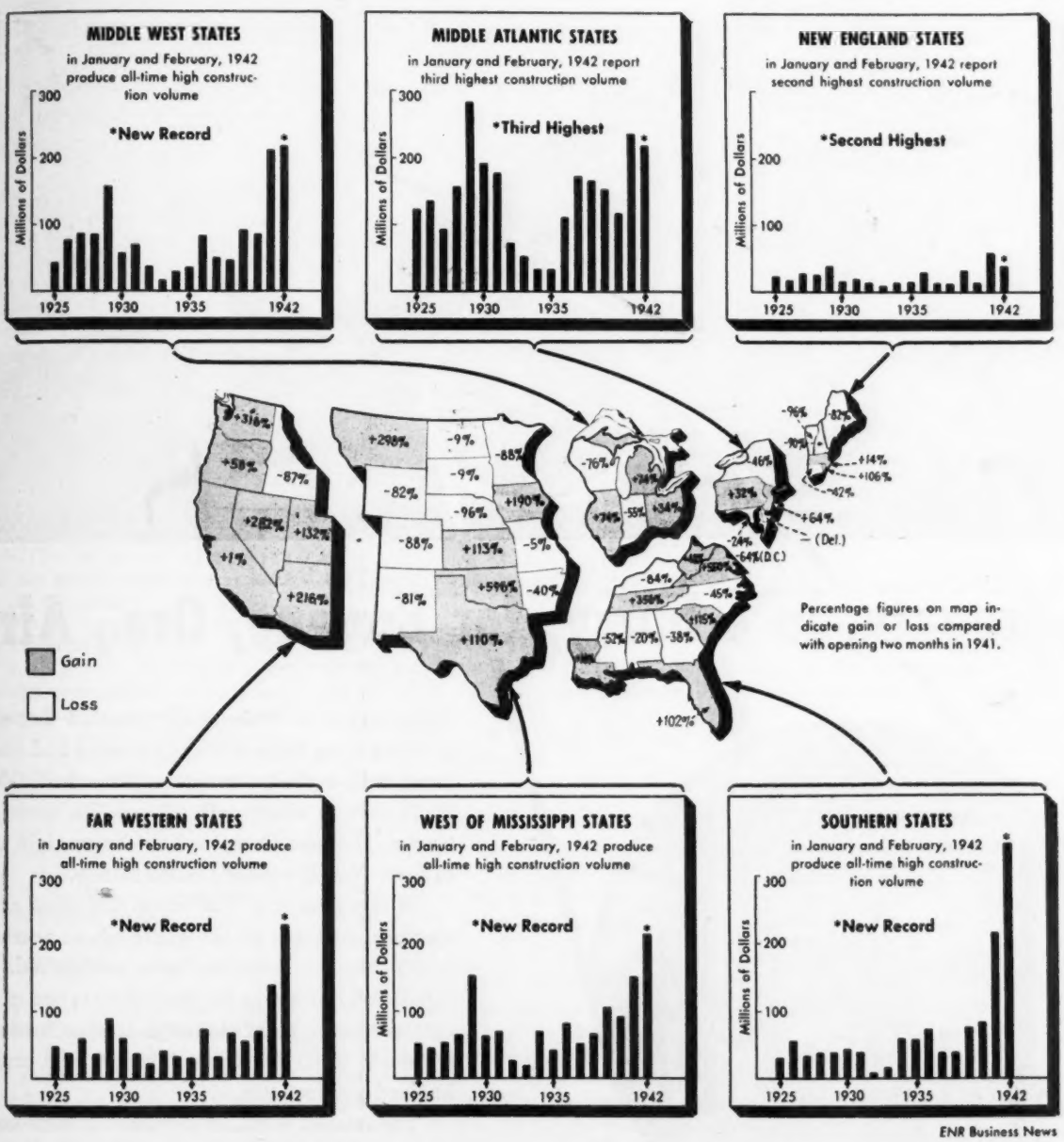
CONSTRUCTION TRENDS

Notes on significant movements in the construction industry

War Projects Boost 1942 Construction to New Peak

Increases in 24 states better nation's 1941 two-month record by 25 percent



ENR Business News

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 TABLE OF CONTENTS—See page 49

PIONEER

Foto Facts **... No. 13**

To build Eugene, Oregon, airport, contractors E. C. Hall of Eugene and J. C. Compton of McMinnville, Oregon, were going to need crushed rock . . . lots of it, and in a hurry. In building their plant, they realized that one of the secrets of Extra Tonnage lies in the secondary roll crusher . . .

Aggregate, in a hurry, for Eugene, Ore., Airport

Construction of strategically situated Eugene Airport involves some three miles of runways and taxiways surfaced with asphaltic concrete. It's a $400,000 contract that's roaring along with all possible speed, and contractors Hall and Compton have every right to be proud of their crushing plant's performance.

In one stretch of 600 hours the plant averaged 92 tons per hour, and for the entire job an average of close to 90 tons per hour has been established. A Pioneer 40x22 roll crusher in the secondary is one of the secrets of this crushing plant's tonnage. It takes the oversize from a Pioneer 3x10 double deck screen and crushes to the finished product size.

The Pioneer 40x22 roll crusher is extra heavy for the tough jobs. It has manganese steel shells 40" in diameter and 22" face — all gear drive — spring release for safety — and positive adjustment.

Upper Photo. General view of crushing plant at Eugene Airport
Lower Photo: Close-up of Pioneer 40x22 roll crusher

FOR FURTHER INFORMATION WRITE, WIRE OR PHONE

PIONEER ENGINEERING WORKS, INC.
1515 CENTRAL AVENUE • MINNEAPOLIS, MINNESOTA

The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • MARCH 26, 1942 • VOLUME 128 • NUMBER 13

Social objectives returned to defense housing program

New officials to reverse Fleming's policies and attempt to fit housing to post-war needs. Prefabrication to be de-emphasized in favor of normal "site" buildings

Effect of last month's reorganization of federal housing agencies it is now clear, was to give the war housing job to the peacetime housing agency, U. S. Housing Authority. The Federal Public Housing Administration, construction unit of the National Housing Agency, is a larger organization that USHA. It has drafted personnel from the near dozen agencies which formerly built housing. But the top men in it are USHA men, and it is dominated by the USHA philosophy.

Since last November, when Gen. Philip B. Fleming took over the Federal Works Agency, the approach to war housing has been an engineering rather than a sociological one. The primary objective was to get roofs up quickly regardless of local desires or consideration for the long range needs of communities where the housing was located. Authority was centralized in the federal government, a few standardized house designs were frozen, negotiated contracts were adopted, and large quantities of prefabricated housing were placed under contract.

Under housing's new administrator, John B. Blandford, Jr., this attitude is reversed. War housing is seen as a continuation under war conditions of the peacetime slum-clearance and housing program. A maximum of local cooperation will be sought, while houses will be of more or less conventional site-fabricated design, varied to meet local conditions.

In most cases houses are to be built through local housing authorities. More than 600 of these are now in existence, and more will be created in the 39 states having enabling legislation. The federal government meets the entire cost and will hold title to the houses, but the local authority, as agent for the government, will actually handle the job.

Once a project has been decided upon in a community, the local authority will retain an architect and an engineer and gather the necessary staff. Technically, these consultants will have a contract with the federal government, but they will be chosen by the authority. The authority will then be responsible for the design of a project and, once the design has been approved by FPHA, the regional offices will advertise for and receive bids. Contracts will almost invariably be placed on an open competitive bid basis, and approval of the contract by FPHA will in most cases only be a formality.

Here again, the construction contractor will legally be dealing with the federal government but in practice with the local authority. FPHA has little faith in factory prefabrication of houses—a procedure which, under FWA, was about to get its first large scale test. It inherits about $150,000,000 worth of contracts with prefabricators, but is rather dubious as to whether the contractors will be able to deliver on schedule. Unless performance under these contracts reveals unsuspected virtues in prefabrication, not many more contracts will be let.

FPHA theory is that all the economies of prefabrication can be attained by "site-prefabrication"—by erecting a well-tooled shop at the work site.

The whole concept of temporary housing is considered rather meaningless. A temporary house is simply a house which gets torn down after the war. At locations where it seems clear that there will be no post-war need, houses needed for the emergency can be built on parkland and other areas not suitable for permanent development, but they will be of the same construction as "permanent" houses.

Governments agree on Alaska highway

Agreement between the governments of the United States and Canada with respect to construction of the projected highway across Canada to Alaska (*ENR* March 12, p. 389) was announced by the Department of State on March 18.

The United States agrees to complete surveys and construction of a pioneer road for its engineer troops, which work already is under way; to arrange for completion of the highway in the shortest possible time under contracts to be let by the Public Roads Administration, employing contractors from either the United States or Canada; to maintain those parts of the highway lying within Canada for six months after the war, and upon termination of the war to permit the parts in Canada to "become in all respects an integral part of the Canadian highway system, subject to the understanding that there shall at no time be imposed any discriminatory conditions in relation to the use of the road as between Canadian and United States civilian traffic."

Canada agrees to acquire rights-of-way for the road in Canada; to waive import duties on shipments between points in the United States and Alaska; to waive import duties, sales taxes, license fees or similar charges on all equipment and supplies used in construction or maintenance of the road by the United States and on personal effects of the construction personnel; to remit income taxes on persons or corporations resident in the United States employed in construction or maintenance of the road; to facilitate the entry of U. S. citizens to work on the road; and to permit those in charge of construction to obtain timber, gravel and rock where such occurs on Crown lands near the highway.

Col. William M. Hoge, Corps of Engineers, U. S. Army, is in charge of surveys and construction of the pioneer road in British Columbia.

Arthur Dixon, chief engineer of the Department of Public Works of British Columbia is preparing plans for a 435 mile link between the Alaska Highway and existing highways of that province. It is planned to use the existing road from Prince George to Vanderhoof, building a new road from there northeast to join the Alaska Highway at Dawson Creek. Cost is estimated at $2,900,000.

Army rushes work on California alien camps as Coast war tension increases

Housing for 10,000 may be ready in month. Standardization, pre-cutting and fabrication planned to speed huge job.

Moving with all possible speed to facilitate the Army's program for removal of more than 100,000 first and second generation Japanese from California defense areas, work was started last week on a reception center at Manzanar, in Owens Valley, some 250 miles north of Los Angeles.

Under instructions from the U. S. Engineer Department, the Griffith Co., general contractors, is assembling materials and equipment for a program that was to see completion of the first houses within 10 days of start of work, and completion of facilities for 10,000 persons within 30 days if military authorities see fit.

Buildings to be constructed will not be dormitories, but will provide separate spaces for each family; each space being a part of a long wooden structure. There will be mess halls, bath houses, laundries, etc.

Great speed in construction will be attained by standardizing, pre-cutting all lumber and assembling structural units before erection. If the plan is carried out to the 10,000 person capacity, 6,000,000 bd-ft of lumber will be required. Foundations are to be precast concrete piers with steel dowels in the piers centering 4x4 in. posts carrying 2x6 in. floor joists.

Siding panels, assembled on the flat, consist of 1x6 in. boards covered outside by 15-lb. felt with battens over the joints. Roofing is to be a 1x6 in. boards covered with 40-lb. felt. Windows slide horizontally on girts running midway between plates and sills, space for the sliding being provided by putting this part of the studding on the flat.

In some of the units, double studs are put in beside partitions to facilitate cutting apart, should it later be desired to move some of the units onto portions of the adjacent land that may be used for cultivation.

Power driven saws in a centrally located mill will do all the precutting, roof trusses will be put together on benches and side panels are assembled, flat, on the floors where they go up.

Water supply for the camp is taken from nearby Shepard Creek, which has been diverted into a 100,000-gal. tank from which a 14-in. steel pressure pipe line runs to the center of the camp. An auxiliary supply from wells may also be used. Tank and pipe were supplied from equipment used in construction of the nearby Mono Craters tunnel of the Los Angeles aqueduct. City forces installed the water system. Sewage disposal plans are being developed by the engineering firm of Koebig and Koebig, Los Angeles.

A similar camp is under consideration on a site near Parker, on the Arizona side of the Colorado River, where some 30,000 to 40,000 acres could be brought under irrigation by the construction of about 20 miles of canal from the Colorado River diversion dam recently completed by the U. S. Reclamation Service.

Since the attack on Pearl Harbor, Dec. 7, the problem of removing enemy aliens, particularly Japanese and those of Japanese descent, has been of major concern to west coast defense authorities, due to the location of many Japanese colonies near new defense plants. The speedy construction of the two centers at Manzanar and at Parker will provide a partial solution for this problem.

Associated Press Photo

Workmen begin rush construction of enemy-alien camp near Manzanar, Calif.

Complete cantonment in record time

An Army cantonment completed in 38 days elapsed time—two full weeks ahead of schedule—has recently been turned over to the commander of Camp Barkley at Abilene, Tex. A War Department announcement said that contracts for camp construction called for completion in 52 days elapsed time, which was considered the minimum period in which such a camp could be built.

In addition to incinerators, storage tanks, gasoline dispensing units and roads and utilities, the camp includes an administration buildings, post office, tropical hospital infirmaries, post exchanges, regimental headquarters, repair shops, kitchens and mess halls, bath houses, and several hundred tent floors and frames.

Chicago water pollution doubled by industry waste

Pollution of lake water entering the 68th St. intake at Chicago has doubled in the last year, according to a survey made by the city engineering department. The average of daily water samples in 1941 showed a count of 405 coliform organisms per 100 cc. as compared with 201 for 1940, the increase being ascribed to larger waste discharges from industries engaged in war production.

Some reduction in the amount of pollution reaching the intake crib might be obtained by increased diversion of lake water, which would facilitate drainage of the waste into the Illinois waterway before it reached the lake. However, a U. S. Supreme Court decree in 1939 restricted diversion for this purpose to 1,500 cfs. Prior diversion was 5,000 cfs.

Meantime, to cope with the increase of pollution, strong efforts are being made to secure priorities for equipment needed to complete the 320 mgd. South District water filtration plant. All of the concrete tanks and galleries for this project are finished, but the superstructure must be built and much equipment installed before the plant can be put to use.

Status of CIO group may be decided by WLB

The vexed question of the status of the CIO's Construction Workers' Organizing committee, and possibly the question of construction labor stabilization agreement between the AFL and the federal government, may soon be passed upon by the War Labor Board. An AFL-CIO dispute over a Farm Security Administration Housing project at Wentzville, Mo., has been referred by FSA to the Conciliation Service and may well be certified by that agency to WLB.

The Wentzville dispute arose when FSA awarded a contract for 100 prefabricated houses to the Home Building Corp., Kansas City, Mo. Home Building is a CIO-organized firm, and when it started work, the AFL tried to stop the job. The War Department was afraid that resulting riots might interfere with operations at the nearby Weldon Springs ordnance plant and also feared the dispute might spread to AFL construction men at Weldon Springs. The War Department asked FSA to stop work, which it did. Subsequently, the army withdrew its request, but FSA has feared to start up the work. Reportedly, WLB pressure was exerted on the contractor either to abandon the contract or join AFL. In any case, the matter has now been turned over to the conciliation service.

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Public Works ordered cut to "bare necessity"

War public works construction, including schools and hospitals, will be cut to "bare necessity" by an order issued last week by Philip B. Fleming, Federal Public Works administrator.

The order affects structures to be built in the $300,000,000 war public works program, and was designed to reduce the use of critical materials and to permit diversion of labor to other production.

One of the immediate effects of the order was the cancelling of a proposed $2,500,000 school construction program at Rome, N. Y., where taxpayers were ready to vote on a $500,000 bond issue as the city's share of the project. Similar action in other localities is expected to follow.

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Reclamation Bureau to explore Trinity project

The United States Bureau of Reclamation has appointed C. W. Burningham, formerly at Grand Coulee Dam, Wash., to investigate possibilities of the Trinity River project in northern California, involving possible diversion of part of the flow of the Trinity River to the Sacramento Valley for irrigation, electric power and other uses.

The Trinity project has been proposed as an emergency means of developing a large block of power for war production. As originally conceived, it would include a large storage reservoir on the upper river near Weaverville, a diversion dam a short distance downstream to turn water into a six-mile tunnel through the Trinity mountains, and about 20 miles of canal, pipe line and other conduits discharging into the Sacramento River near Keswick. Power plants would be located at the base of the Trinity River storage dam and probably at three power drops along the conduit system.

Mr. Burningham will make his headquarters at Reading, and will devote the first part of his study to determining present and future water demands in the drainage basin of the river itself.

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Mechanical engineer named

Edward E. Ashley, consulting engineer, is the consulting mechanical engineer for the "Clinton Hill" development of the Equitable Life Assurance Society in Brooklyn, N. Y. (*ENR*, Feb. 5, 1942, p. 213).

New York must pay for storm flood damage

Award of $37,285 to 124 Forest Hills, Queens, N. Y., property owners for flood damage to their homes has been announced by a special referee appointed by the State Supreme Court.

The awards, to be paid by New York city, were based on a court action in which property owners alleged that the city was responsible for overflowing of an "inadequate" storm sewer during a "cloudburst" in 1938 (*ENR*, Feb. 19, 1942, p. 302).

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Jersey will interconnect existing water systems

The New Jersey state legislature last week passed a series of measures to carry out recommendations of a special committee which had urged interconnection of the state's major water supply systems in order to avert shortages during the war emergency.

Measures passed include one which sets up a revolving fund of $300,000 to be used by the Water Policy Commission in effecting the interconnections.

Canadian approach to prefabricated housing

Faced with much the same problem as confronts U. S. communities in the matter of providing homes for workers attracted to war industries, Canadians have also been developing types of prefabricated housing, including those shown above, being erected at Halifax, N. S., by Wartime Housing, Ltd., of Toronto, Ont.

These sectional houses arrive at the building site in six different units, after assembly at a Halifax mill. The buildings are placed on floor panels 4x12 ft., framed with 2x8-in. joists, and cross supports of 2x4-in. They are covered with moisture-resisting board over which tongue and groove fir flooring is nailed in place. Standard house size is 24x24 ft., with inside divisions according to three standardized plans. Side wall panels are 2x4 frames with windows already in place. Outside of the house is covered with weatherproofed plywood and painted with synthetic resin paint. Roof panels, covered with plywood sheathing, are bolted in place from the inside. The roof covering comprises 210 lb. square tab asphalt shingles for fire resistance and wear. Inside finish is wall board, and the houses are completely insulated.

Adjustment of standards to war needs reported at A.R.E.A. annual meeting

American Railway Engineering Association has undertaken revision of its specifications for track materials to meet war conditions. Substitution of non-crictical materials urged by the WPB.

Temporary revision of the specifications for track materials now contained in the Manual of the American Railway Engineering Association to make them more adaptable to war conditions has been undertaken. This action of the board of direction of the association was reported by F. L. C. Bond, president, in opening the annual meeting of the association, held in Chicago, March 17–19. At a later session, Andrew Stevenson of the transportation equipment branch of the War Production Board, urged the association to adopt a policy of substitution of non-critical materials for critical materials in its maintenance work. Mr. Stevenson suggested substitution of clay pipe for iron and steel in culvert and drain work and substitution of mass concrete for reinforced concrete.

Eastman urges simplification

Joseph B. Eastman, director of the Office of Defense Transportation, laid special stress in the need for simplification of specifications and simplification of standards in the interest of economy of materials and speed of manufacture. "I submit," he said, "that present conditions do not permit the luxury of all manner of special designs. This is true of cars and locomotives, and I am glad to say that that fact is being given practical recognition in the cars and locomotives now under construction. But it is also true of joint bars, tie plates, spikes, frogs and switches. It will also be necessary in many instances to use substitute materials, as, for example, malleable iron in place of steel, and much ingenuity will be required in that connection".

Mr. Eastman said that shortages of rail and track will make necessary the use of temporary makeshifts in preference to work planned from the long-range point of view and added that vigilance, imagination and foresight will be needed to make available materials contribute the most to efficient handling of war traffic.

A.R.E.A. specifications

Replacement of the specifications for portland cement now in the Manual by those adopted last year by the A.S.T.M. was recommended by the committee on masonry (and adopted by the association), this action being supplemented by similar replacement of the matter on high-early-strength cement and methods of sampling and testing cement. Tentative specifications for plain and reinforced concrete for bridges and other structures, and specifications for test borings, and the lining of tunnels with brick, shotcrete and metal liner plates, were also submitted.

While no detailed report was made on the results of impact tests, the committee on impact gave interesting particulars of its work, which has included runs with steam, electric, and oil-engine locomotives at speeds as high as 100 m.p.h. on girder bridges having open decks and on ballasted concrete decks.

Structural foundation soils and their bearing capacity were discussed by the committee on roadbed and ballast, this report also covering the bearing capacity of piling. This committee presented specifications for corrugated metal drain pipes and culverts, multi-plate galvanized culverts and vitrified clay culvert pipe.

Rail and track studies

Controlled cooling of rails has given highly satisfactory results, according to the committee on rail. In 3,500,000 tons of such rails purchased during the six years since controlled-cooled rails have been made and sold under contract, only seven transverse fissures and four compound fissures have occurred, and of all these only two of the rails with transverse fissures showed shatter cracks.

The eighth annual progress report on the investigation of rails in service, presented by Prof. H. F. Moore (University of Illinois), covered field tests of batter on end-hardened rails and the development of shatter cracks. Batter is greatly reduced with end-hardened rails.

In a lengthy report the committee on maintenance-of-way work equipment discussed new developments in roadway machines and greater use of such machines and power-operated tools, especially in the use of motors of higher power. There is need for further reduction in weight, and room for the introduction of many new machines, the committee said. Along the same line was a report of the committee on economics of railway labor on the reduction of maintenance labor forces due to the introduction of machinery. In recent improvement work on the Great Northern Ry., excavation was handled by tractor-drawn elevating graders and drag-line machines; the material was hauled by carrying scrapers and by dump trucks loaded by crawler-mounted shovels, and the dumped material was leveled and compacted by bulldozers. Off-track equipment is being used increasingly for work of this kind.

Work for college men

The committee on relations with the universities reported that the railroads are showing some increase in the demand for college-trained men to provide employees qualified for advancement, yet they "have not reflected this demand to the same degree as other industries, nor to the extent to which they are justified." This has caused "some educators to become definitely critical, almost to the extent of being pessimistic."

Association affairs

President F. L. C. Bond, reported that while the association is in a good condition financially, the expense of maintaining the Manual in its present form has become burdensome due to the fre-

H. R. Clarke heads A.R.E.A.

H. R. Clarke, chief engineer maintenance-of-way of the Burlington Lines, was elected president of the American Railway Engineering Association at its annual meeting at Chicago Mar. 17-19. A native of Ireland, Mr. Clarke graduated from Monmouth College, Monmouth, Ill., in 1906, and after a year with the Missouri Pacific went to the Chicago, Burlington & Quincy R. R. as a rodman on construction, becoming successively instrumentman, foreman, resident engineer on construction, roadmaster, general roadmaster, district engineer maintenance-of-way, engineer maintenance-of-way of Lines West, general inspector of permanent way, engineer maintenance-of-way System, and later engineer maintenance-of-way Burlington Lines. On Jan. 1 of this year his title was changed to chief engineer maintenance-of-way. Mr. Clarke joined the A.R.E.A. in 1922. He is a past president of the Roadmasters' and Maintenance of Way Association and of the Maintenance Club of Chicago.

quent changes proposed by committees.

Research work is to be continued actively, new work including fatigue tests on structural welds. Financial support for this work will continue to come in large part from the Association of American Railroads, of which the A.R.E.A. is the engineering division. Under a new agreement between the association and the University of Illinois, the university will continue its study of rail joints and will take up a new study of the relation of wheel treads to the cross contour of rail heads.

Herbert R. Clarke, chief engineer maintenance-of-way, Burlington Lines was elected president and F. R. Layng, chief engineer, Bessemer & Lake Erie R.R. was elected second vice president. W. F. Cummings, chief engineer, Boston & Maine R. R., automatically succeeded Mr. Clarke as first vice president. New directors are G. L. Sitton, chief engineer maintenance-of-way and structures, Eastern Lines of the Southern Ry.; R. A. Van Ness, bridge engineer of the Santa Fe System; and C. E. Smith, vice president of the New Haven.

The National Railway Appliances Association held its "Railway Show" in the exhibition hall of the Palmer House.

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Urge parking garages as post-war traffic measure

Looking to a post-war period when lifting of restrictions on supplies for privately-owned cars will greatly increase the number of vehicles on the city streets, the New York Regional Planning Association has prepared a five-point program to clear legal and zoning obstacles to traffic and parking efficiency in the congested downtown district.

The program is intended to lay the groundwork for a post-war system that would include the use of parking meters on some streets; erection of modern central garages; creation of a parking authority with power to create self-liquidating parking terminals wherever needed; increased off-street truck-loading spaces and other new techniques, including better regulation of design, location and operation of all parking accommodations.

The Association's suggestion for construction of parking garages would require an amendment to the zoning resolution. Regulation of methods and operation of parking garages and parking lots would be handled "through appropriate city agencies."

Harold M. Lewis, chief engineer and planning officer of the Association, said that New York still classifies the garage as a nuisance use of land, permitting such establishments in the retail and business districts only as exceptions, under temporary permits.

Canadian Quartermaster General to retire

Maj. Gen. E. J. C. Schmidlin, quartermaster general and senior engineering officer of the Canadian Army has been granted retirement leave preliminary to retiring from active duty.

An announcement of Gen. Schmidlin's impending retirement said that "considerations of health impairment consequent upon his continuous heavy duties and responsibilities under war conditions" have necessitated the move.

Gen. Schmidlin, a graduate of the Royal Military College of Canada, went overseas in 1915 with the rank of brevet lieutenant colonel, serving in France and Belgium as commander of a batallion of Canadian engineers, and was the recipient of the military cross. On his return to Canada, he was appointed professor of military engineering at the Royal Military College and became successively professor of engineering, senior professor and professor of engineering. He became director of engineer services at the National Defense Headquarters in January, 1934, and held that post until April 1940, when he was appointed acting quartermaster general. He was named quartermaster general, with the rank of major general, on July 24, 1940.

Hearing scheduled for Patapsco bridge plans

Lieut.-Col. Conrad P. Hardy, district engineer, will hold a public hearing Mar. 31 in Baltimore on the application of the Maryland State Road Commission for War Department approval of location and plans of a bridge across the Patapsco River, between Fairfield and Canton.

Plans filed with the Corps of Engineers call for construction of a fixed highway bridge of steel truss construction with arched underclearances, resting on concrete and steel piers. The channel span would be 1,260 ft. center-to-center of piers, the central portion of which will have a vertical clearance of 133.9 ft. above mean high water.

Survey New York subways for air raid safety areas

Although no decision has been made as to whether the subway tunnels will be used as air raid shelters, engineers for the New York City Board of Transportation are completing surveys of the more than 127 miles of track-tunnel in the city's combined subway system.

From a preliminary study, it has been found that about 10 miles of tunnel, most of it in the Washington Heights section of Manhattan Island, and in the Prospect Park area of Brooklyn, meet requirements for a reasonably safe shelter for about 40,000 persons.

In selecting shelter zones, engineers considered the amount of rock and earth coverage. Areas selected were required to have either 30 ft. of rock or 50 ft. of earth between the top of the tube and the street. Most of the stations, set immediately below the street level, do not meet the requirements. Also taken into consideration were proximity to water mains and rivers; sanitary facilities available, and the number of emergency entrances.

Also studied were the advantages of long underground passageways between stations of the Sixth Avenue division of the Independent subway system, which were found to be strong enough to resist blast and fragmentation, but not safe from a direct or near hit.

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War forces curtailment of Canadian road work

Road construction, and repair and upkeep of all private and public roads in Canada, except those made of concrete, will undergo "drastic curtailment" this year, according to a recent announcement by the Munitions and Supply Department.

Explaining that there are shortages of asphalt, petroleum asphalt, and steel used to reinforce concrete highways, the Department's announcement said that new construction will be possible only for roads regarded as essential defense arteries, and for links between existing roads and new military camps and war production plants. One artery considered essential, the Department said, is the Alaska highway now under construction by U. S. Army Engineers.

J. D. Lorimer, chemicals controller, said that a new regulation will prohibit the sale or use of coal tar for the construction or repair of roads without a permit from the war time industries control board. Commenting on the petroleum situation, the announcement said that some petroleum asphalt for repair of public highways may be available, but there will not be enough for any extensive road construction.

WASHINGTON HIGHLIGHTS

IN ITS FIRST MOVE to enforce the restrictions imposed on builders operating under the housing priorities plan, the War Production Board this week withdrew priority assistance from a Washington, D. C. builder and excluded a Washington architect from having any connection for a year with priority aided projects. The Stearns-Mishkin Construction Co., which is building several housing developments in Washington, retained Matthew G. Lepley, an architect, to obtain priority assistance. In obtaining a P-55 rating, Lepley represented, on behalf of the builder, that the houses were to be sold to government workers at less than $6,000. According to WPB, many of these houses actually were sold at higher prices.

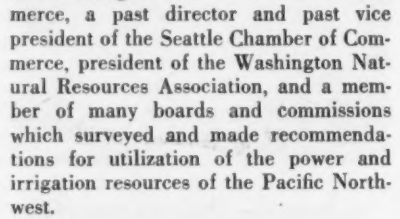
As punishment, all priority aid has been withdrawn until Mar. 1, 1943 from the construction company unless it repays to buyers of its houses the excess over $6,000. WPB has also ordered that until next March no priority aid be granted to any construction project with which Lepley is directly or indirectly connected.

AS ONE OF THE FIRST formal exercises of his power to control Army and Navy procurement methods, WPB chairman Donald Nelson told the services to eliminate the rule by which all contracts between different branches of the service and between the branches and civilian agencies must be handled through the branch chief. Previously, an officer in say, the Corps of Engineers who wanted to do some business with a WPB official, was, at least technically, required to write to the chief of engineers, who would then write to the head of the WPB unit. who would transmit the communication to his subordinate. Now, says Nelson, let the officer simply phone the man he wants to deal with. Action taken can be subsequently confirmed "through channels" if necessary.

THE STOP-ORDER on non-essential construction has been, as was anticipated, (*ENR*, Mar. 19, p. 1) somewhat delayed by disagreement within the War Production Board over the terms of exemption from the requirement that no building proceed without a priority rating. Issuance is now not expected for a week or more. It also appears that the cost limits on exempt construction will be somewhat lower than those in past week's draft, which set them at $1,000 for housing and $25,000 for other buildings. However, other clauses will exempt reconstruction and rehabilitation work and farm buildings.

Joseph Jacobs, Seattle consulting engineer, dies

Joseph Jacobs, 72, consulting engineer long identified with reclamation projects, died suddenly in Seattle, Wash., March 16. A past president of the Pacific Northwest Society of Engineers, he had just completed a term as vice president of the American Society of Civil Engineers. Mr. Jacobs also was a director of the Washington State Chamber of Commerce, a past director and past vice president of the Seattle Chamber of Commerce, president of the Washington Natural Resources Association, and a member of many boards and commissions which surveyed and made recommendations for utilization of the power and irrigation resources of the Pacific Northwest.



Born in Leavenworth, Kan., Mr. Jacobs had been a resident of Seattle for more than 30 years. His long career included engineering work for numerous railway companies, for the U. S. Geological Survey, and, since entering private practice, investigations and designs for local, state and government irrigation, power and water supply and bridge projects. These included Grand Coulee and Cedar River dams, the Skagit River power project, the Columbia Basin irrigation project, and the Puget Sound-Grays Harbor-Columbia River canal investigation, in Washington. Other projects were designing of a reclamation project in Porto Rico and investigation of the irrigation possibilities of the Snake and the Deschutes Rivers in Oregon; the Rio Grande, Colorado; the San Joaquin, American, Willamette, Lewis, and Spokane Rivers in Washington.

During the first World War, Mr. Jacobs served overseas with the Corps of Engineers with the rank of major.

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Move concrete laboratory

The Central concrete laboratory of the North Atlantic Division, U. S. Engineers, will be moved from its present location at the U. S. Military Academy at West Point, N. Y. to 320 Washington St., Mount Vernon, N. Y., on April 1.

PRIORITIES GUIDEPOST

Current notes on what, who and how

HOUSEBUILDERS making use of the priorities granted by WPB for privately-financed war housing must hold their houses available for defense workers for at least thirty days after completion under the terms of a new set of regulations governing the housing priorities plan. When applying for a rating on houses for rent, moreover, the builder must specify the rental he proposes to charge and keep that rental actually in effect for at least a year.

MANUFACTURE of medium cast iron soil pipes is eliminated by the fourth schedule issued under the plumbing and heating equipment simplification order, L-42. Weights of the extra-heavy C.I. soil pipe are reduced by the order and brass pipe plugs and trap screws are forbidden on soil pipe fittings.

REDUCTION in the use of metal lath as a base for plaster and stucco is being considered by WPB.

HEAVY construction trucks designed to operate off the highway and weighing twelve tons and up may be equipped with tires by the manufacturer under a modification of WPB rulings.

RAILROADS are to be allocated 1,260,000 tons of heavy rail this year, WPB has decided.

DISTRIBUTORS of building, construction, hardware, plumbing, and railroad supplies, as well as various other specified distributors are granted further priority assistance under a new plan intended to keep up distributors inventories. The distributor, on applying on Form PD-LX, will be granted a rating on specific quantities of material—sufficient probably to keep at least a two-month inventory in stock.

• • •

Screen incinerator ashes to recover scrap steel

In an attempt to salvage as much scrap steel as possible from an estimated 5,000 tons of tin cans burned each year in its four incinerators, the City of Toronto, Ont., has established a new screening plant.

Residue of the incinerators is trucked to the screening plant and dumped upon sloping grate bars set at a 40 deg. angle. The ash falls through to the ash bin, while the tin cans and large clinkers accumulate on the storage floor. The city will sell recovered cans to a metals salvage company.

OBITUARY

George W. Hawley, 52, deputy engineer in charge of 650 dams in the division of water resources, California Department of Public Works, died at Sacramento Mar. 17. A graduate of Stanford University, Mr. Hawley had been an engineer for the Oregon Electrical Co., the San Joaquin Irrigation District, and the East Bay Water Co. in California before joining the State Department of Water Resources.

Edward C. Schmidt, 67, who retired two years ago as professor of railway engineering at the University of Illinois, died Mar. 21 in New York.

Anthony J. Bemis, vice-president of Day & Zimmerman, Chicago consulting engineers, died at Chicago, Mar. 21.

Harry Tucker, 52, an associate member of the North Carolina State Utilities Commission, and formerly professor of highway engineering and director of the Engineering Experiment Station at North Carolina State College, died Mar. 18 at Raleigh. He had been on leave of absence from the college since his appointment to the Utilities Commission early in 1941. The author of many engineering textbooks, he served as a captain in the Corps of Engineers in World War I.

Adam Clarke Davis, 52, head of the department of experimental engineering at Cornell University, died recently at Ithaca, N. Y.

Franklin A. Snow, 87, for many years prominent in civil engineering in New England, died at Brookline, Mass., on Mar. 19. Early in his career he had been chief engineer for contractors excavating the Culebra Cut of the Panama Canal, and for the past forty years was active in underground conduit construction for electric utilities.

George L. Butts, 83, for nearly thirty years sanitary engineer with the Providence, R. I., Department of Health, died at Providence Mar. 20.

William B. Honska, 58, civil engineer and bridge builder, died recently at Helena, Kans.

William H. Floyd, Jr., 90, the oldest member of the Missouri Society of Civil Engineers, died recently at his home in St. Joseph.

Harry C. White, 56, a civil engineer employed by the W. T. Roberts Construction Co., at Cambridge, Mass., died Mar. 16.

Edward A. Bertram, 76, retired civil and structural engineer, died recently at his home in Berkeley, Cal.

Amos S. Congdon, 64, former chief engineer at the Lorain yards of the American Shipbuilding Co., died in Lorain recently.

Frank L. Niederheiser, 76, city engineer in Bucyrus, Ohio, for more than 30 years, died Mar. 14.

William R. Ury, 59, general superintendent for the Mason & Hanger Co., New York, died Mar. 22. He was general superintendent for the company on many of its large contracts, including work on the Catskill aqueduct, two East River subway tunnels, the Lincoln Tunnel, and Merriman Dam.

John Mailer, 73, construction engineer with Baker Perkins & Co., of Saginaw, Mich. for 30 years, died Mar. 13 at Rahway, N. J.

Albert W. Wingender, former inspector for the Milwaukee water department and inventor of the Badger water meter, died Mar. 12. He was 80 years old.

Henry N. Potts, 61, a British civil engineer who had served as chief engineer of the National Iron & Steel Works of Mexico, died in Mexico City recently.

CONTRACTS AND CAPITAL

ENGINEERED CONSTRUCTION volume for the week, $177,115,000, tops the corresponding 1941 week's total by 40 percent, but is 35 percent lower than the near-record volume of a week ago. This is the tenth consecutive weekly construction volume to top the $100,000,000-mark.

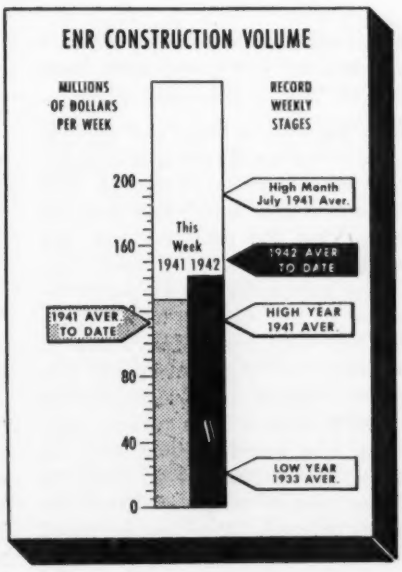
Private construction exceeds the 1941 week's total by 6 percent, and is up 47 percent compared with the preceding week. Public volume increases 46 percent over a year ago, but is 40 percent lower than a week ago.

The current week's construction brings 1942 volume to $1,993,088,000, a gain of 36 percent over the $1,461,248,000 reported for the 13-week period last year. Private construction for the period, $187,704,000, is 52 percent below a year ago, but public work, $1,805,384,000, is up 69 percent as a result of the 119 percent federal gain.

In the classified construction groups, gains over the preceding week are in sewerage, industrial buildings, and unclassified construction. Increases over the volumes for the 1941 week are in waterworks, sewerage, industrial and public buildings, and unclassified construction.

New capital for construction purposes for the week totals $7,448,000. This compares with $606,685,000 for the corresponding week last year. The current week's new financing is made up of $3,850,000 in corporate security issues, $2,598,000 in state and municipal bond sales, and $1,000,000 in RFC loans for public improvements.

New construction financing for the year to date, $1,419,454,000, is 6 percent above the $1,332,653,000 reported for the opening quarter in 1941.



CONTRACTS

(Thousands of dollars)

	Week Ending Mar. 27 1941	Mar. 19 1942	Mar. 26 1942
Federal	$86,221	$246,829	$146,652
State & Municipal	21,370	13,350	10,620
Total public	$107,591	$260,179	$157,272
Total private	18,693	13,523	19,843
TOTALS	$126,284	$273,702	$177,115
Cumulative 1942 (13 weeks)			$1,993,088
Cumulative 1941 (13 weeks)			$1,461,248

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1941 13 weeks	1942 13 weeks
NON-FEDERAL	$260,153	$177,499
Corp. Securities	63,503	60,410
State & Mun.	157,149	101,840
U.S.H.A. loans	13,521	.....
R.F.C. loans	25,980	15,249
FEDERAL	$1,072,500	$1,241,955
TOTAL CAPITAL	$1,332,653	$1,419,454

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	Mar. '42	269.71	129.65
Building Cost	Mar. '42	218.88	118.32
Volume	Feb. '42	507	222

FHA MORTGAGES

	Week Ending Mar. 22 1941	Mar. 14 1942	Mar. 21 1942
Selected for appraisal			
Title II	$32,830	$17,103	$17,470*
Title VI		$24,566	$20,128*

* Subject to revision.

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

Higher Steel Stresses

Sir: A letter from Bruce Johnston (*ENR* Feb. 12, 1942) mildly criticizes the suggestion in my letter (*ENR* Jan. 1, 1942) that higher unit stresses for structural steel are justified during this emergency.

Although Mr. Johnston gives records of structural steels that he has personally tested, which have yield points under 33,000 lb. per sq. in., a review of thousands of mill reports in my office covering steel purchased in the last three years from Bethlehem, Carnegie and Canadian steel mills shows that there was no single case where structural steel was delivered with a yield point under 36,000 psi., and it usually was closer to 40,000. It may be pertinent to point out that the Canadian National Railways requires a minimum yield point of 35,000 psi. in contrast to the 33,000 specified by the A.S.T.M., and it may be for this reason that we get higher yield points than those reported by Mr. Johnston.

Mr. Johnston's warnings against careless and indiscriminate raising of unit stresses are well taken, but it seems to me to be significant that there are thousands of railway structures still in service in America and Canada that were designed on a 16,000-lb. unit stress basis between the years 1890 and 1898 to carry a Cooper's E-40 loading. In no instance have I seen or heard of a failure in any of these bridges, although, to my certain knowledge, some of them are carrying loads equivalent to Cooper's E-70, which means stressing them well up past 8/10 of the yield point of the steel.

It is on this fact that I base my belief that it would be perfectly safe to design aerodromes, steel mills, factories, office buildings, etc., during the war period, with stresses in them at least equal to what occurs in railway bridges fifty years old. Surely if it is safe to handle locomotives at 70 and 80 m.p.h., with all their unknown factors of stresses, etc., over steel stressed up to 8/10 of the yield point, it should be safe in a desperate war emergency to stress new buildings designed during the war to an equal amount.

My whole suggestion is based on my patriotic desire to assist our war effort in every possible way. Canada, I might point out, has already raised the unit stresses in buildings intended for war purposes up to 25,000 psi.

C. P. Disney
Bridge Engineer
Canadian National Railways
Toronto, Ont.

Sir: Mr. Disney's mill reports covering steels purchased from Bethlehem, Carnegie and Canadian steel mills, which show a yield point above 36,000 psi., are also in accord with the writer's experience, but it should be pointed out that the steels tested by the writer were rolled by these same sources within the past two years.

The disparity between mill test reports on yield point and the actual results of careful laboratory tests is common knowledge among a number of engineers of the writer's acquaintance. Two possible reasons for this disparity occur to the writer, although there may be other factors involved:

(1) The mill test is apt to be run off at a speed which will actually indicate a higher yield point than can be obtained at slow speed.

(2) The higher speed at which a mill test is run may result in an overrun of the counterpoise.

It is the writer's belief that the laboratory test has always been accepted as a better criterion of strength than the mill test, although this does not imply that the mill test does not achieve its purpose as a control test.

The substandard yield points reported by the writer in his February 12 letter were intended as a note of warning, but of course do not represent a typical proportion of what might be expected for a larger sampling. The samples tested were all taken from material $\frac{3}{4}$ in. thick or thicker, and all except one were from plate material. Material in rolled beams, or in plate thinner than $\frac{3}{4}$ in., will usually show higher yield points than the specification minimum because of the more thorough rolling treatment. Even in large samplings, which have included coupons from beams as well as plates, substandard yield points are encountered, however. It seems to the writer that these facts, together with the experience of Mr. Disney, emphasize the importance of careful inspection and test on the part of the consumer. Whereas a railroad may exercise such control, it is difficult for a research laboratory, ordering in small lots, to obtain corresponding results.

In connection with old bridges it seems questionable whether their good record constitutes sufficient reason for raising stresses for the design of new bridges. An engineer recently told the writer that during the last war, wooden warehouse design was arrived at by building a structure successively weaker until one fell down—and by this procedure the desired design was achieved.

Such practice may be necessary and desirable to save material during the present crisis, but these methods should not be confused with what is good practice for permanent structures.

Bruce Johnston
Associate Director
Fritz Engineering Laboratory
Lehigh University
Bethlehem, Pa.

Sir: In his letter (*ENR* Feb. 12, 1942) Mr. Bruce Johnston cites laboratory tests of A.S.T.M. A-7 steel, some of which had surprisingly low yield points. He does not refer to the fact that full-size structures show better results than test pieces; in testing a full-size transmission tower, for instance, anything less than a 36,000 base is practically unknown. One may add that such a base is referred to static calculations on limit design principles, but ignoring secondary stresses (after studies of their effects) even though connections are very eccentric. No unusual procedures are involved.

The load capacity of a structure depends upon two factors, first the assumed loadings, second the unit stresses. One might add a third, the designer. Many writers of specifications merely copy old specifications, and say 40 or 50 or 60 lb. per sq. ft. for roof load quite without thought of the actual probable roof load. Some roofs will have to carry snow,

and some will not. Some will have other than the usual loads upon them. Wind loads vary greatly, and should vary in specifications. Further, wind and snow-load stresses are usually combined, and this may or may not be advisable, depending on the particular conditions.

Let us suppose a writer of specifications carefully selects twice the roof load that he needs, and twice the wind load that would be safe. Let us suppose that he wishes these impossible loads to be combined. Let us assume that he wishes such a unit stress to be used that these severally impossible conditions could be repeated in combination 2,000,000 or more times. Then the question arises, "How much practical difference does it make whether he uses a unit stress of 20,000 or 30,000 psi.?" And the answer is obviously in terms of weight, not in terms of usefulness.

Mr. Johnston speaks of building structures without any determination of stress or strain, and suggests calling the procedure "limit design." A cut and try method is apparently largely used by the automobile fraternity. That application of limit design, however, which seeks to determine the failure point in advance of tests, and often more accurately than by other methods, is usually preferable.

C. M. GOODRICH
The Canadian Bridge Co., Ltd.
Walkerville, Ont.

Reinforced-Brick Shelters

Sir: Reference is made to the photograph on p. 48 of your Jan. 29, 1942, issue. The picture shows construction in England and carries the caption. "Many surface shelters of brick may soon be scrapped and replaced by reinforced-concrete structures."

There has been considerable confusion and loose thinking in England by laymen on the subject of air-raid shelters. The original surface shelters in that country were built in a rush with plain brick masonry and in many cases, as the official reports show, with lime mortar. Thus, the builders in their haste disregarded all the recommended practices of brickwork known to engineers and contractors. Such weak construction naturally was found to be unsatisfactory and is being replaced by reinforced-masonry shelters. These reinforced shelters in some instances are of reinforced concrete, in others of reinforced brickwork.

Comparison of plain brick masonry of the weakest sort with reinforced concrete unfairly and illogically condemns good brick masonry and, of course, does nothing but confuse the reader on the subject of reinforced-brick masonry. British authorities have strongly recommended the use of reinforced-brick structures of the type illustrated in the photograph, and have indicated that they are just as good as reinforced concrete—and more economical, since formwork is eliminated. In fact, the text of the story, of which the photograph is a part, indicates that brick masonry is one of the best forms of construction to use for this very item. This is due to the masonry's lower tendency to shatter.

J. H. HANSEN
Secretary
Brick Manufacturers Association of New York
New York, N. Y.

Prestressed Concrete

Sir: The excellent article by H. L. Whittemore "Material Shortages—Redesign and Substitution" (*ENR*, Jan. 15, 1942, p. 112) clearly points out one of the most important tasks engineers have to deal with.

Referring to the proposition to economize in reinforced-concrete structures and yet maintain safety, I would like to call attention to prestressed reinforced-concrete structures and to one type in particular, because it is very economical and easy to produce. This system has been developed by Dr. F. Emperger in the last few years. It is based on the new idea of combining two different types of reinforcement in one concrete structure: i.e. deformed or plain bars of normal yield point, not prestressed and placed and bent in the usual way; and smaller bars of high-yield point, prestressed and arranged at suitable distances from the first-mentioned reinforcement. As the prestressed bars are of small diameter, as a rule only wires, no special anchorage is necessary. By determining the proper ratio of the cross-sections of the two different reinforcements, 20 to 50 percent of the steel can be saved through this method. And there is the further advantage that cracks caused by live load will close after its removal. Many series of tests have proved these qualities, and it is very interesting that at the same time safety against impact and heavy shocks is considerably increased.

This method is especially suited for prefabricated units since stationary apparatus simplifies the prestressing. Excellent results have been obtained with girder spans as long as 150 ft.

OSKAR SCHREIER
Civil Engineer
New York City

P. S. In a letter by me published in your issue of Dec. 18, p. 863, the decimal point was misplaced in the figure for the moment for cement mortar. The factor should be 0.045.

Cofferdam Design

Sir: Reference is made to A. F. Hedman's most excellent article on cofferdam design for Kentucky Dam (*ENR* Jan. 1, 1942 P. 30). The description of the basic facts determining the design and reasons for adopting the controlling features of the design are given with accuracy and completeness not always attending this type of article.

The various quantities in this structure are so large that any fractional saving rapidly multiplied into large sums of money, and this required a rather delicate balance of a rational safety factor for the structure against its economies. For example, the use of $\frac{3}{8}$-in. web piling as compared with $\frac{1}{2}$-in. web piling saved 2,500 tons of piling, or 13 percent of the tonnage. This saving was made possible by test driving and comparison of the specimens of the two weights of piles and by comparative pull out tests on the interlocks. The use of a two-stage cofferdam presented a substantial tangible saving, to say nothing of the added advantage of requiring only two plant setups within the cofferdams instead of three for concreting and related operations.

The use of a 60-ft. dia. cell undoubtedly contributed greatly to economy since the portable template design which the Tennessee Valley Authority has used at Pickwick, Guntersville, Chickamauga, and Watts Bar Dams is feasible for handling this unit up to 60 ft. in dia. Above 60-ft. dia. the weight of the portable template increases beyond feasible limits for handling equipment or requires a large amount of in-place construction.

I believe that this is the first time the manufacturers of steel sheet piling have guaranteed interlock stresses at 16,000 pounds per lin. in. for this type of construction. Without this cooperation by the manufacturers, a considerably more expensive design would have been required. I believe it is also correct to state that the piling order for this cofferdam was at the time the largest-placed single order for piling in the history of the manufacture of this commodity.

L. A. SCHMIDT, JR.
Construction Engineer, Hales Bar Dam
(Formerly Construction Plant Design Engineer)
Tennessee Valley Authority

Open Cut Soil Pressures

Sir: The article "Open-Cut Soil Pressures on Chicago Subway" by R. S. Knapp and R. B. Peck (*ENR*, Nov. 20, 1941, p. 739) is a very interesting contribution to the much-discussed and still controversial subject of soil mechanics.

In Fig. 4—Total lateral earth pressures, determined as linear function of unconfined compressive strength of soil—the results deduced do not correspond with many observations in the Detroit area. The clays in the Chicago and Detroit areas are considered very similar.

Following in general the theory of lateral pressure based on shearing strength of soil:

$$q = 2\,m'$$

$$K = \frac{w\,H - 2\,m'}{w\,H}$$

$$\text{Lateral pressure} = wH - 2\,m'$$

$$\frac{2\,q}{w\,H} = \frac{4\,m'}{w\,H}$$

m' = shearing strength of soil, other symbols the same as in the article.

The above relations were used in computing the superimposed curve shown in the adjacent chart. Values of H were taken as 5, 10, 15, 20, 30 and 40, each with values of shearing strength of soil, $m' = 200$, 400, 600, and 1,000. This gives higher values for the lateral pressure and, I believe, more safely indicates the ultimate, unrestrained pressure that could be expected in most earthwork in plastic material.

It should be axiomatic that if a soil is so soft that it has no unrestrained compressive strength it would exert full hydrostatic pressure laterally at any depth. That is when $q = 0$

$$\frac{2\,q}{w\,H} = 0 \text{ and } K = \frac{w\,H - 0}{w\,H} = 1$$

This is borne out on the superimposed curve (designated as Curve A on accompanying chart) which gives an intercept of unity on the Y axis. The line extended from the test data gives an intercept of 0.75± which does not seem reasonable.

In Curve A the intercept on the X axis gives a value of 1.55±. That is no lateral pressure exists when $\frac{2\,q}{w\,H} = 1.55$. Referring to Fig. 2 of the article and the text

$q = 1020 \pm$. Assuming W = 125

$$H = \frac{2\,9}{W \times 1.55} =$$

10.5 ± ft. for zero lateral pressure.

As the strut at 13-ft. depths shows very high loading (230 ± kips), it seems improbable that zero pressure existed only 2½ ft. above.

No doubt many factors enter to make differences of this kind, some of which may be the time element, the action of the wedge of soil in tipping, extent that shearing resistance is mobilized, longitudinal dimensional effect, etc. This results in a complicated analysis of the individual case. An excellent discussion is obtainable in "General Wedge Theory of Earth Pressure" by Karl Terzaghi, American Society of Civil Engineers *Transactions*, Vol. 106, p. 68, 1941.

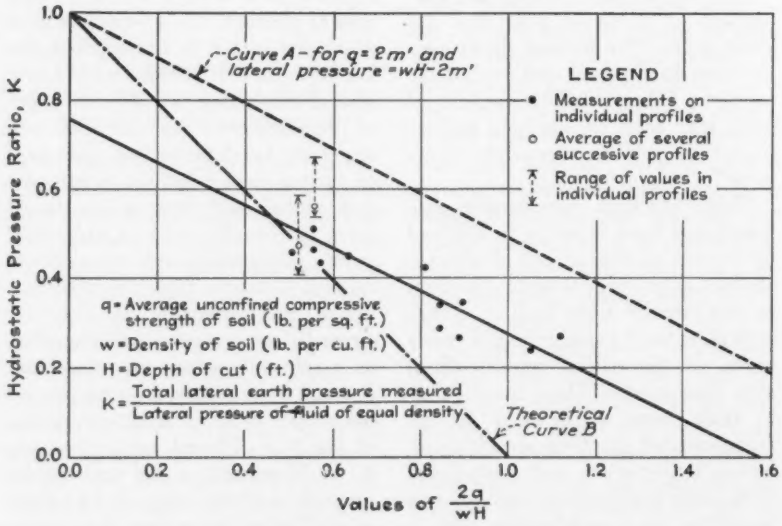
FRED H. BURLEY
Detroit, Mich.

Sir: The above comments by Mr. Burley partly arise through a misconception of the meaning of Fig. 4 in the article. In this chart, the hydrostatic pressure ratio has been defined as the *total* lateral earth pressure measured, divided by the total lateral pressure of a fluid of equal density. Mr. Burley has defined the hydrostatic pressure ratio as the ratio of lateral *intensity* of pressure at some particular depth to the equivalent fluid *intensity* of pressure at the same depth. These two definitions do not lead to the same result.

The authors wish to point out that Fig. 4 does not represent a theoretical deduction, nor was it suggested as a basis for design. It is simply a plot of the experimental values of measured earth pressure and the corresponding experimental values of unconfined compressive strength determined in the laboratory. If there is any discrepancy between these measured values and the values given by a theory, it is the theory which must be adjusted to fit the facts, rather than the facts altered to suit the theory. Using the theory of lateral earth pressure suggested by Mr. Burley, the expression for lateral pressure is

$$p_A = wH - 2m'$$

The total lateral pressure between the surface and depth H is equal to



Reproduction of Fig. 4 of original article, to which Mr. Burley's "superimposed" Curve A and the authors' theoretical Curve B have been added.

$$P_A = \int_0^H (w\,H - 2m')\,dH = \tfrac{1}{2}\,w\,H^2 - 2m'\,H$$

The hydrostatic pressure ratio according to the definition given on Fig. 4 in the article is, therefore, equal to

$$K_A = \frac{P_A}{\frac{1}{2}\,wH^2} = \frac{\frac{1}{2}\,w\,H^2 - 2m'\,H}{\frac{1}{2}\,w\,H^2} =$$

$$1 - \frac{4m'}{w\,H} = 1 - \frac{2\,q_c}{w\,H} = 1$$

From the latter equation it is apparent that the following two conditions exist

$$\text{when } q_c = O, K_A = 1$$

$$\text{also, when } K_A = O, \frac{2\,q_c}{w\,H} = 1$$

Therefore, the theoretical curve should intersect the hydrostatic pressure ratio axis at the value 1.0 as suggested by Mr. Burley. On the other hand the curve must also intersect the horizontal axis at a value of 1.0.

The theoretical curve is, therefore, not the "superimposed curve" (A) indicated by Mr. Burley, but a line indicated as Curve B on the attached sketch. The reasons for the deviation of the measured values from the theoretical curve have been discussed in a paper presented by R. B. Peck at the fall meeting of the American Society of Civil Engineers, in October, 1941, to be published in A.S.C.E. *Proceedings*. The authors are inclined to believe, on the basis of the evidence presented in that paper, the reduction of shearing resistance in the field due to progressive failure is sufficient to account for most of the apparent discrepancy.

Inasmuch as the results in Fig. 4 deal with *total* pressure, and contain no information whatsoever regarding the distribution of earth pressure with depth, no deductions regarding the improbability of high strut loads in the upper part of the cut are justified. The measured strut loads shown in original Fig. 2 definitely indicate the presence of arching which causes the center of pressure to rise. Since this occurs, it is obvious that the classical earth pressure theories cannot be used for determining *distribution* of pressure, because they are not in agreement with reality. The reasons for this fact have been well set forth in the paper by Karl Terzaghi, to which Mr. Burley has referred.

R. S. KNAPP
R. B. PECK
Dept. Subways and Superhighways
Chicago, Ill.

Steel in Concrete Pavements

Sir: In the article, "Trends in Concrete Pavement Design" (*ENR*, Feb. 12, 1942, p. 93), A. A. Anderson states, in effect, that the exigencies arising out of the present war effort —insofar as they affect the design of concrete pavements—are being met largely by eliminating what he terms the "needless refinements" embodied in former design practice.

The statement is made that "steel is being reduced or entirely eliminated by minor changes in slab section and by improved spacing of expansion and contraction joints." Such a statement may well be questioned by asking—Is the provision of an additional inch or more of concrete thickness throughout the major portion of the paved area, as is needed when reinforcement is omitted, to be construed merely as a "minor" change? Also, since a joint at best is an undesirable feature in any concrete pavement, is the use of two to three times as many transverse joints (and undowelled joints at that), as would otherwise be needed in a reinforced pavement, to be viewed in the nature of an "improvement"?

As to the present emergency practice of omitting steel reinforcement from concrete pavements, this does not, as the article in question would lead one to believe, reflect any changed attitude on the part of highway engineers in respect to either the need for or the efficacy of reinforcement. The truth of the matter is that, insofar as engineering judgment is concerned, engineers generally have been reluctant to abandon their reinforced designs. Nevertheless, as an emergency expedient, they have been compelled to reverse their former design practice and have adopted non-reinforced pavements, not only as a steel-conservation measure, but also as an effective means of expediting the prompt issuance of priority ratings on highway projects.

But to infer that this sudden abandonment of reinforcement, dowelled joints, and other established structural features represents a design "trend" is a presumptious implication. The word trend, as applied to structural design, implies practices widely accepted as the result of experience and accumulated knowledge —not practices abruptly born of sheer necessity to meet an unexpected emergency.

Actually, the real trend in concrete pavement design practice has not been toward the elimination of steel reinforcement but, on the contrary, toward its more widespread use. That this has been a continuous and increasing trend is shown by the fact that, prior to the present emergency, which first began to affect highways only a few months ago, those states that did not reinforce their concrete pavements constituted but a small minority.

Notwithstanding the present need for conserving steel in every practicable way, there are and will continue to be certain highway projects which, by virtue of their military importance if for no other reason, will justify the highest standards of structural design, even under emergency restrictions. It is important, therefore, that engineers maintain a clear concept of what constitutes good engineering practice as distinguished from make-shift design procedures adopted purely as momentary expedients for the sole purpose of conserving the use of materials which happen to be critical because of the present emergency.

R. D. BRADBURY
Engineer-Director
Wire Reinforcement Institute
Washington, D. C.

Tangent Distances for Runways

Sir: On p. 95 of your Dec. 4, 1941, issue, in the article by Jos. L. Grimes, Jr., entitled "Tangent Distances For Runway Intersections," it would appear that Mr. Grimes could substitute the value of Cot. $A' = T'$ in Equation 7 of his solution. This would reduce his solution to a simpler form; namely, where B is less than 90 deg.:

$$T' = \frac{a + a' \cos C}{\sin B} \text{ and } T = \frac{a' + a \cos B}{\sin B}$$

and where B is greater than 90 deg. to:

$$T' = \frac{a - a' \cos B}{\sin B} \text{ and } T = \frac{a' - a \cos B}{\sin B}$$

These formulae were devised in the design section of the Los Angeles Road Department some fifteen years ago and have been in constant use since.

C. W. SPROTTE
Division Engineer, Road Department
Los Angeles County, Calif.

EDITORIALS

VOLUME 128 NUMBER 13

March 26, 1942

Only Courage Cuts Red Tape

MANY A PERSON READ with much satisfaction the Nelson-Patterson memorandum of last week ordering an end to the time-consuming practices of "going through channels," i.e., bringing every minor problem to the attention of a host of superior officers before taking action; and of writing letters instead of using personal interviews and the telephone on urgent matters. Let no one suppose, however, that such an order is a magic wand that can make red tape disappear. Only forthright action by subordinates can cut red tape, and the requisite for that is not an order from the boss but individual courage. Red tape is just another name for established procedure, and cutting it means, in plain language, to flout it, when necessary. Too few persons have what it takes to act first and get confirmation afterward. But that is what is required. It is required from superintendents and foremen, from inspectors and field engineers, from army engineers and navy public works officers. Flouting procedure does not mean flouting authority. It merely means getting a thing done and writing its history afterward. The Nelson-Patterson order does no more than replace a red light with a green one. Whether traffic moves any faster depends, as always, on the guts of the man in the field.

De Luxe Inspection

AKIN TO RED TAPE as a brake on war construction are the unrealistic inspection practices that are still allowed to exist. Instances have been reported where there are more inspectors on a job than there are supervisory personnel on the contractor's payroll; where tolerances in finishes are required that have no relation to the serviceability of the facility; where inspectors require work to be held up to suit their personal convenience. Bad enough in peace-time, such practices are inexcusable now. To urge that they be discontinued is not to plead for special privileges for the contractor. Rather is it to plead that we get on with the job without penalizing the war construction program. These contractors were hired because the Army and the Navy had confidence in their ability. And it is their "know how," not that of the inspectors, that is being paid for. If, instead of acting as policemen, inspectors would visualize their job as one of aiding the contractor—interpreting specifications for him, getting unreasonable specification clauses modified, seeking permission for him to use alternate materials or procedures when such seem justified—great good would be accomplished. Many inspectors do so visualize their jobs. Someone in authority should educate the rest.

Selling Is Harder Than Designing

THE QUEST for new and better designs, which has always pervaded engineering activity, has produced one inescapable conclusion: the actual designing is simple compared with the problem of getting it used. The principal difficulty lies first in obtaining approval of the various layers of authority above the designer and then in passing the antiquated building codes and supervision imposed by statute. Even in war work, a new and admittedly good design submitted from the outside has a long, hard road to acceptance. For example, a new type of underground munitions storage is described in this issue. It was developed by a contractor and offered to the government as a contribution to the war effort. The design and the construction of a model occupied only a few days, but final acceptance for use required more than two months of the hardest effort. Probably it should be made less difficult to give the government something for its own good, but, until it is, those who develop a new product must believe in it sufficiently to carry on a campaign in its behalf, and must be willing to spend time and money to see it through.

WPA and Road Maintenance

PROPOSALS HAVE BEEN MADE for the WPA to take over part of the normal maintenance of roads to offset an anticipated decline in road income due to curtailed use of motor vehicles. Such a proposal has been made by the Michigan Association of Road Commissioners and Engineers (*ENR* March 5, p. 337); and a like proposal was made in the form of a question to Perry A. Fellows, chief engineer of the WPA, at the A.R.B.A. meeting in Memphis. In his answer Mr. Fellows gave the basic objection to such a proposal, namely that to turn

normal road maintenance work over to the WPA in order to pass part of the cost to the federal government would means the replacement of regular workers paid at regular rates by relief workers paid at relief rates. It stands to Mr. Fellows' credit that he did not mince any words in saying that the proposal is unsound and that he is opposed to it. Less enlightened WPA officials who are seeking to insure perpetuation of the WPA by continually expanding its activities would do well to paste Mr. Fellows' example in their hats. Regular public work is not a WPA function either now or any other time.

Cutoff Walls of Asphalt

THE FIRST USE of what may well be the forerunner of important developments in dam construction—asphalt for cutoff walls—is reported in this issue in more detail than has been available in the past. This application was in one abutment of the dam for the Claytor hydro-electric project near Radford, Va., completed late in 1940, where a hot sand-asphalt mix was used to form a cutoff wall across a wide zone of bad ground.

The possibilities of this method for correction of similar bad underground conditions at other dams, or even for making cutoff walls in earth or rock-fill dams, appear to be large. As a construction material, the hot sand-asphalt mix has many advantages. It is easily prepared and handled, and, because of its ability to weld itself into a homogenous mass, construction joints are no problem. From the design angle, the fact that an asphalt mix maintains a considerable amount of flexibility for an indefinite period gives assurance that the wall will adjust itself to settlement or other minor movements without rupture. In fact, it appears possible that this material might be used to form a watertight diaphragm in a rock or earthfill dam and that by installing heating pipes in the sand-asphalt mix as it is placed, sufficient fluidity could be maintained to assure complete adjustment to settlement during a long period following construction.

Hot asphalt has been used in the past for sealing construction joints in dams. It also was used to grout the foundations of Hales Bar Dam, but that application did not prove to be permanently successful because a complete asphalt diaphragm was not created and the soft rock that was left ultimately dissolved out. The method used at the Claytor plant promises to be more successful.

Not a Closed Book

THERE CAN BE LITTLE DOUBT that the Supreme Court's decision of March 16 in the natural-gas rate case (p. 488) will have a great effect on utility valuation work to which so many engineers have devoted their time during the past three or four decades. Careful reading of the decision, however, indicates no basis for many early newspaper reports to the effect that the court has thrown out old methods of utility valuation in favor of the "prudent investment" theory. Such substitution was recommended by three justices in a separate opinion, but all the court said was that rate-making bodies are no longer bound "to the service of any single formula or combination of formulas."

The significance of the decision lies in its revelation that the court no longer requires the elaborate weighing of "all elements of value" that the Supreme Court in the past has made an essential part of all rate-base determinations. The historic decision in the case of *Smyth vs. Ames*, on which all rate regulation for nearly 50 years has been based, said that "the present as compared with the original cost of construction" was among the several elements that must be considered in determining a rate base. The court now says that these elements need not be considered.

That consideration of these elements will be discarded immediately, however, seems highly unprobable. In the first place, there are more regulatory bodies than there are states, and all these agencies have built up systems that can hardly be discarded at a moment's notice. But a more important consideration appears to be the lack of any well-established substitute. The "prudent investment" theory of rate-base determination, long advocated by the late Justice Brandeis, has been applied to a limited extent, but still is only a theoretical consideration so far as most regulatory bodies are concerned. Thus, valuation work as it has been practiced during the past few decades is far from being a closed book.

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WALDO G. BOWMAN, *Editor*. E. J. CLEARY, *Managing Editor*. *New York:* V. T. BOUGHTON, J. I. BALLARD, A. N. CARTER, H. W. HUNT, E. R. DENMARK, *Chicago:* H. W. RICHARDSON. *Washington:* PAUL WOOTON, R. B. COLBORN. *San Francisco:* N. A. BOWERS, *Consulting Editors*, F. E. SCHMITT, W. W. DeBERARD
EDITORIAL OFFICES: 330 WEST FORTY-SECOND STREET, NEW YORK, N. Y.

Navy Drydocks Make Construction History

ONE OF THE SPECTACULAR and heartening developments of the times is the way engineers and construction men have tackled the huge drydock building program that war tossed into their laps. Whether the unusual initiative that has been displayed by Navy civil engineer officers, civilian engineers and contractors is a result of careful studies during a long period of inactivity in drydock building or whether it is born of natural resourcefulness and daring released by the challenge of war, it is difficult to say. There is no doubt, however, that the design and construction methods that have been employed on the drydock work are notable in the extreme. Not only have they produced drydocks in record time, but they also have set precedents that can be used in other types of construction operations.

Some of the precedents will be recalled from previous articles appearing in these pages. There was, for example, the use of an elaborate system of well points to dry up one of the sites from which the sea had been excluded by a small cofferdam at the outer end. On another job deep-well pumps, later installed as a part of the drydock operating equipment, were used to supplement well points in accomplishing the drying-up job. On one drydock a cableway was employed to distribute the concrete, while on another this operation was done by a belt-conveyor installation.

Important, however, as these developments are, they are exceeded both in significance and spectacular quality by a method of building the entire concrete drydock under water. This method, illustrated on the opposite page, has been used for several of the largest drydocks on the program, and its significance may be appreciated by the fact that each drydock has required the placing of over 250,000 cu. yd. of tremie concrete.

The general procedure employed in this method of drydock construction is evident from the pictures on the opposite page, but to supplement this information the following details may be noted.

Site preparation consisted in dipper dredge excavation to nearly 70 ft. below high-tide level, after which the bottom was leveled off with an I-beam drag and covered with a 2-ft. layer of crushed stone.

Next, floating pile drivers were brought in to drive 60-ft. steel H-piles until their tops were about 3 ft. above the bottom. Spaced about 5 ft. on centers, some 7,000 of these piles were required to support the drydock.

With the site thus prepared, floating derricks lowered steel box forms onto the piles ready for concreting the 14-ft. thick bottom. Divers helped to land the forms, and slender detachable towers extending above the water surface permitted instrument men to check line and grade. These forms, of corrugated steel sheets braced with steel trusses, extended entirely across the drydock and permitted placing the bottom in 12-ft. strips. Some 13 ft. at either end of these bottom forms was partitioned off and poured with the walls, which were built in similar forms. The steel bracing in the forms was figured as reinforcing steel and was supplemented by bars, some as large as 3 in. square. A section of bottom form weighed about 120 tons.

Concrete placing was done from equipment mounted on a railroad car float and fed by pipelines from a land-based mixing plant with a capacity of 250 cu. yd. per hr. Equipment on the car float consisted of four pairs of building hoist towers 40 ft. high, which carried the concrete pipelines on a platform connecting their tops. The pipelines discharged into fixed hoppers hung between the pairs of towers, and these in turn discharged into sliding hoppers on the face of the towers which connected directly with the 60-ft. long 12-in. dia. tremie pipes.

The eight tremie pipes permitted the placing of concrete over a 158-ft. width of bottom at one time. By beginning concreting in the tremie at one end and continuing progressively across the dock, by allowing no sidewise translation of tremie pipes during concrete placing, by avoiding breaking tremie seals, and by excluding all water from the pipe before starting work, a concrete of exceptional quality was produced. It is claimed that these drydocks are the equal in every way to drydocks built in the dry, which claims, if substantiated by service records, should greatly widen the potentialities of tremie-placed concrete.

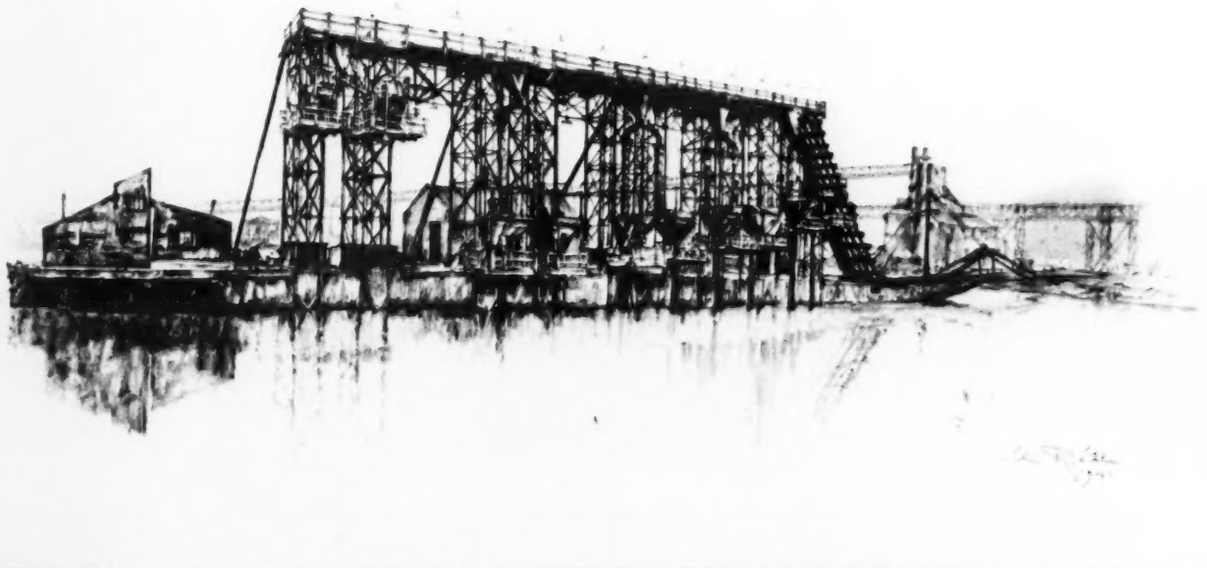
BUILDING DRYDOCKS U

Lowering forms for drydock floor. Loops shown are hairpin bars that will project from the tremie-placed floor to anchor a surface course placed in the dry.

ENGINEERING NEWS-RECORD is privileged to present these striking examples from a book of drawings on United States naval drydock construction, prepared by and published for Spencer, White & Prentis, Inc.; Foley Brothers, Inc.; and Merritt-Chapman & Scott Corp., the combination of contracting firms that did the work for the United States Navy.

They depict one of the most significant and spectacular construction operations to be generated by our 1941 war program, the building of huge shipbuilding drydocks entirely of tremie-placed concrete. This underwater method of drydock construction was originated by Rear Admiral Frederic R. Harris (CEC) USN, Retired, consulting engineer on the work. The design and construction were carried out under the supervision of the Bureau of Yards and Docks of the United States Navy, of which Rear Admiral Ben Moreell (CEC) USN is Chief.

The drawings are by the talented artist, Miss Lili Rethi, and in the language of the foreword of the book "are dedicated to those who labored with head, heart and hand to make these important enterprises a success".



Tremie-concrete barge to which concrete is brought from shore by pipelines that discharge into hoppers over the tremie pipes.

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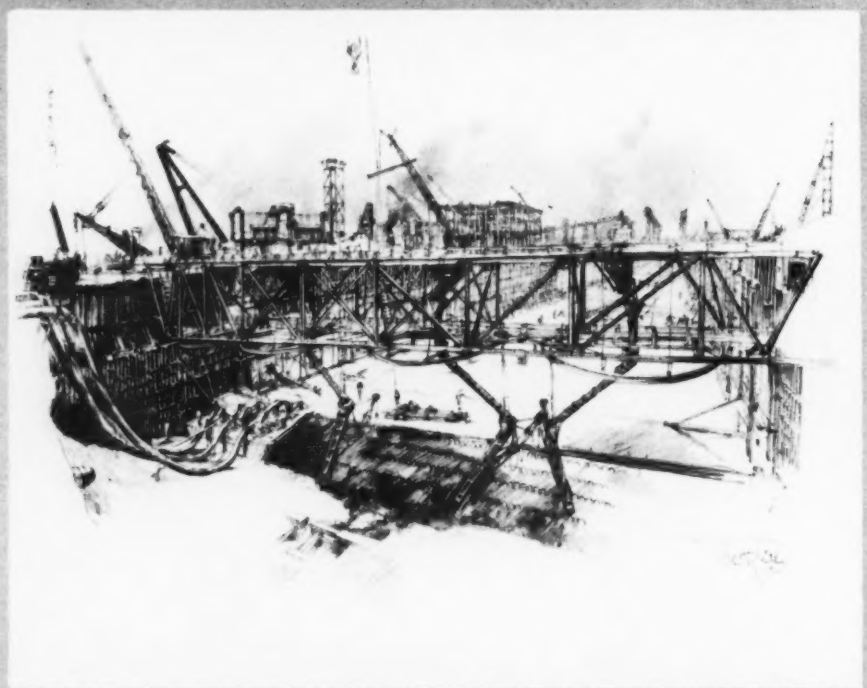


Dewatered with barge-mounted pumps, the drydock floor is being paved with concrete chuted from a traveling bridge spanning between the dock walls.

Drydock approaching completion. Top lift of walls is an intricate concrete section containing utility pipes and power conduits.

UNIV. OF MICH.

Warehouse Without Priority Materials

INSTEAD OF LOOKING for priorities a Cleveland, Ohio, engineering and construction firm looked for materials when they were given an order for a storage warehouse. They found timber and clay products available and some stocks of bar joists which they combined into an acceptable design for quick and economical construction. As soon as the tentative design was approved by the consulting engineers, all materials were purchased and moved to the site of the work, making the area somewhat congested but assuring availability of the parts when needed.

Estimates of the cost of the job were made after the materials available were determined. A permanent structure, with 21-ft. clear height, was thus secured by the owner at a favorable contract price for the bare enclosure, and an overall cost of $2.15 per sq. ft., including all mechanical installation, some of which was done with the owner's maintenance crew. Mechanical installations included heat, sprinklers, light, and plumbing.

Materials available for the building permitted a design with 12 x 12-in. vertical timber columns spaced at 33 ft. 4 in. by 20 ft. These were capped by 16 x 16-in. timber beams across the 20-ft. span. Steel bar joists, 3 ft. apart with a clear span of 32 ft., cross the other direction. The mill type roof is completed with 2 x 6-in. "dressed and center matched" lumber topped by a 4-ply smooth surface built-up asphalt roof. Walls are of brick and, as they must supply much of the lateral stability of the structure, are 13-in. (3 courses) thick. Pilasters, at 20 ft. spacing, are 21-in. (5 courses) thick. More than a half-million common brick were used in the walls. Some hollow load-bearing tile is substituted for brick in areas not within pilasters and not subject to impact. A 5-in. reinforced-concrete slab was placed for the floor after most of the construction was completed.

Small spread footings carry the timber columns. Angle clip plates are used on two sides of the columns with lag-threaded bolts into the timber and two anchor bolts in the footing. A copper encasement is provided for the bottom of the timber column to prevent dampness from the floor or the ground starting decay of the wood. When the floor slab is placed, a small space is left open around the base of the column and this is filled with bituminous material to further assure freedom from moisture.

Heavy clip angles are bolted to the top of the columns and are fastened with lag screws to the under-side of the beams. At the pilasters each beam is tied down with a bolt to a connection laid in the brick 11 ft. below the top. The bar joists are welded to steel plates which are connected with lag screws turned into the top of the 16 x 16 in. timber beam. In each 32 ft. bay two sets of rod-bridging are used with their ends welded to the joists and the bars welded where they cross. The bar joists each have a nailer strip on the top flange and to these the 2 x 6-in. D&CM roof lumber is fastened with a 20-d and a 16-d nail.

Erection of the timbers was done by a small diesel-powered crane on crawler treads that also set bundles of bar joists upon the roof. The joists were skidded along the beams to the proper spacing and then welded to the bearing plates. Work was started in November and the enclosure rushed to avoid working in the open in severe winter weather. The floor slab was placed in January after salamanders and unit heaters, the latter circulating the heat from the salamanders as well as their own, had been used to completely thaw the ground.

The building was designed and constructed by the James C. F. Shafer Company of Cleveland, for the Lorain Division of The American Stove Company, at Lorain, Ohio. Carter Richards Company of Cleveland were consulting engineers for the owners and approved the design and construction.

Use of bar joists, 16x16-in. timber beams and 12x12-in. timber columns permits simple winter construction with material available without priority.

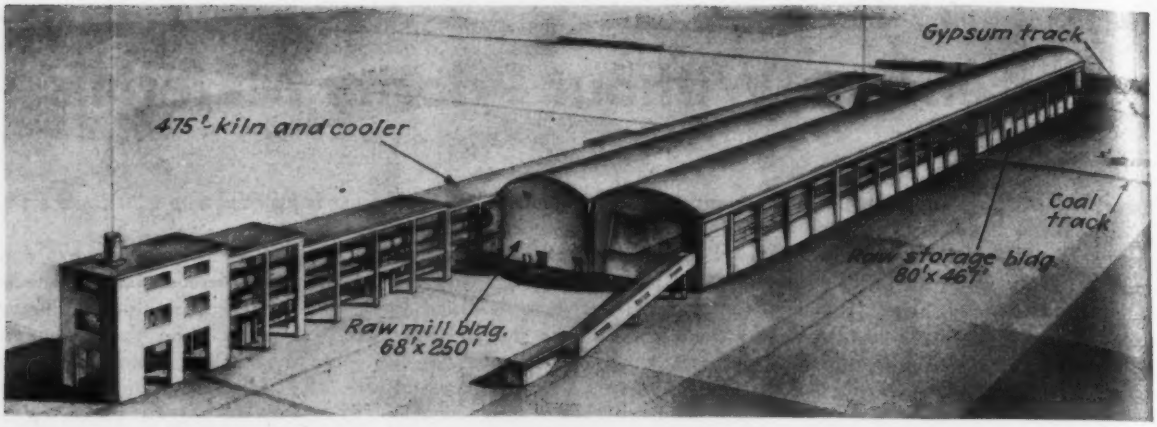


Fig. 1. Traditional use of steel was discarded in favor of all-concrete construction on Marquette's new mill at Des Moines.

Sliding Scaffolds Speed Cement Plant

***Contents in Brief**—Two 100-ft. traveling scaffolds, 50 ft. high, served as form falsework and working platforms on the construction of a high arched-roof concrete building for storage of raw materials at Marquette Cement Company's new cement plant at Des Moines, Iowa. The building, 470 ft. long and 65 ft. high, is a concrete shell of unusual design and appearance. New facilities include country's longest kiln.*

DEPARTING from the anomalous tradition of designing cement plants largely of steel, the Marquette Cement Mfg. Co. is building a new all-concrete mill at its recently-acquired Hawkeye plant at Des Moines, Ia. Included in the new facilities is a raw materials storage building of unusual design and striking appearance. It is a concrete shell 470x80 ft. in plan and 65 ft. high with a concrete arched roof.

Just as interesting as the design is the method of construction by the contractor, Arthur H. Neumann & Bros. Inc., Des Moines, who use two traveling scaffolds 100 ft. long, 34 ft. wide and 50 ft. high as roof form support and working platforms. Other new parts of the mill consist of two more monolithic concrete buildings, concrete slurry tanks, a 475-ft. kiln (longest in the country), an office building and coal, raw material and clinker grinding and handling equipment facilities. Some of these facilities are being built under separate contracts; awards for others have not yet been let.

The raw materials structure consists principally of a series of transverse concrete bents, 20 ft. apart, made up of columns along the outside wall line, crossbeams under the floor and arched roof beams carrying an arched concrete roof of 77-ft. clear span. Some 2,000 precast concrete piles were required under the continuous column footings and the floor crossbeams. Outside building dimensions are 80 ft. width, 470 ft. length and 65 ft. overall height. There are four transverse expansion joints in the structure, formed by split double columns and beams and a complete break in roof and floor slabs.

Running the full length of the building, about 37 ft. above the floor, is a traveling craneway of 75-ft. span. Main columns up to the craneway are 3 ft. 2 in. deep, 20 in. wide (double expansion joint columns are each 16 in. wide). Spanning between columns to carry the crane track on each side are 18x30-in. concrete girders. The columns extend above the craneway for another 5 ft. in much smaller section than below, topped by a continuous spandrel wall 10 in. thick and 4 ft. high. The roof framing ties into the upper columns and spandrel. Roof construction consists of arched roof beams, same width as columns, and 2 ft. deep, carrying a 3-in. concrete roof slab supported on eleven concrete purlins. At the haunches of each arched roof beam is a cross-tie made up of four angles, welded back to back into a cross, supported by seven hanger rods. The roof slab is covered with composition roofing.

The interior is divided into eight storage compartments of various lengths by transverse retaining walls 12 ft. high. These bins will store limestone, silica, diaspore, iron, shale, coal, clinker and gypsum. Retaining walls, at the two building wall lines, form the ends of the compartment. Eleven concrete hoppers are scattered through the building in three groups, into which the various materials will be loaded by the overhead crane. Except for curtain walls that partly enclose the ends, and the hopper walls, the building is open to the weather between top of retaining walls and bottom of spandrels. Two transverse railroad tracks cut through the structure for delivery of raw materials.

Traveling scaffolds

From a construction standpoint the neatest trick of the job is building the high arched roof from a pair of sliding scaffolds. These are identical structures, set side by side inside the column lines, 100 ft. long, 34 ft, wide and 50 ft. high. They are

of bolted timber construction, riding on shoes over tracks supported on low cribbing.

The top of each scaffold is a solid working deck that just clears the tie rods in the roof, for the rods are placed as the roof is built, and all forms and supports must be knocked down to deck level before the scaffolds can be moved ahead. Expansion joints divide the building into sections from 80 to 100 ft. long. The scaffolds are designed to handle a roof section between expansion joints. They are equipped with both stairways and ladders for access to the working deck.

Construction procedure is to move the two scaffolds ahead—one at a time—by block-and-fall lines hooked to an electric hoist. Track and cribbing are built to careful grade, and as the scaffolds are rigid enough to carry the forms without bracing and anchoring, the traveling falsework is in correct position and ready for form erection as soon as the two units have been moved.

Pile driving, footers and the crossbeams at ground level are the only parts of the structure built ahead of the falsework. Thus, the scaffolds move out into the open after a section is completed. First, the column forms up to the crane track level (all in panels) are set by cranes working from the outside. These forms are braced to the scaffolds.

After the columns are poured the roof and spandrel forms are erected. These forms are plywood panels, supported on the scaffold top deck by conventional building form jackshores. The tie rods are then placed, and the roof poured. Then, to clear the tie rods, it is necessary to move all forms and supports to one scaffold unit. The clear unit then is moved ahead, and before the second unit can be moved all top forms must be shifted to the first unit by hand passing over a bridge between the two units. Next the second unit, now clear to deck level, is moved ahead and its forms are passed across the narrow gap between the two units.

Ordinary scaffolding is erected on the outside of each section being poured. From the top of this falsework runways are built over the roof area. Concrete, mixed in a paver, is hoisted in buckets to a hopper at the top of the outside scaffolds by a long-boom crawler crane and wheeled from the hopper to forms in buggies.

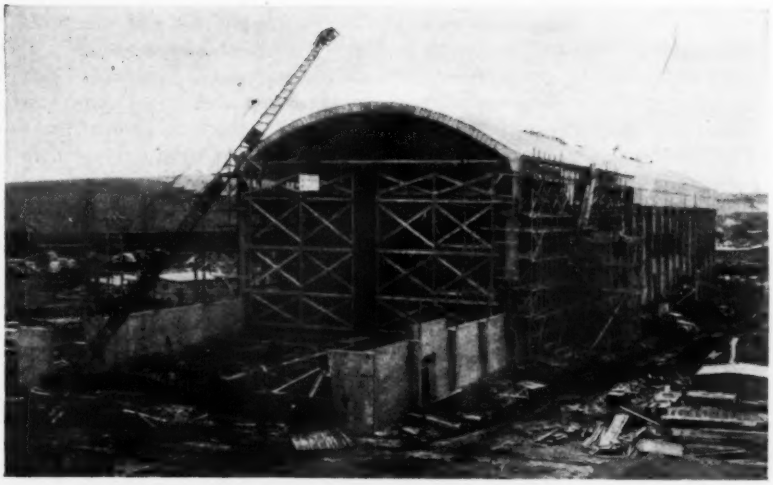


Fig. 2 (a). Traveling scaffolds support roof forms and serve as working platforms on raw storage building. Note (above) that scaffold is now ready for a move.

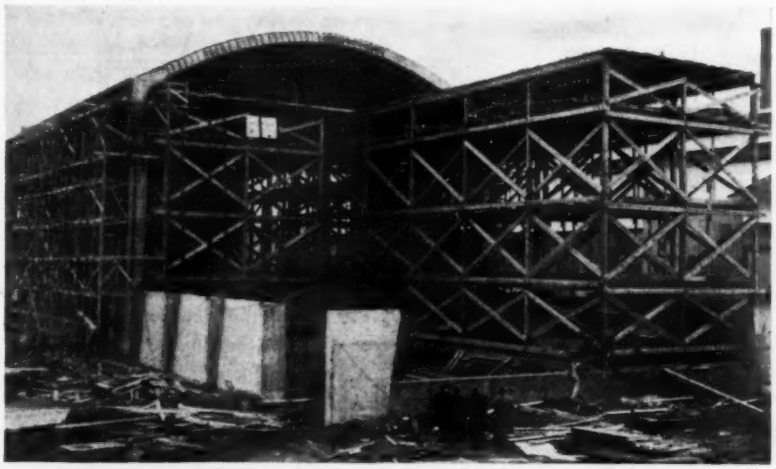


Fig. 2(b). One scaffold has been moved ahead to a new location; the other one will be shifted when the forms have been transferred to the one ahead.

Fig. 3. Arched roof gives the raw storage building a clear span of 80 ft.

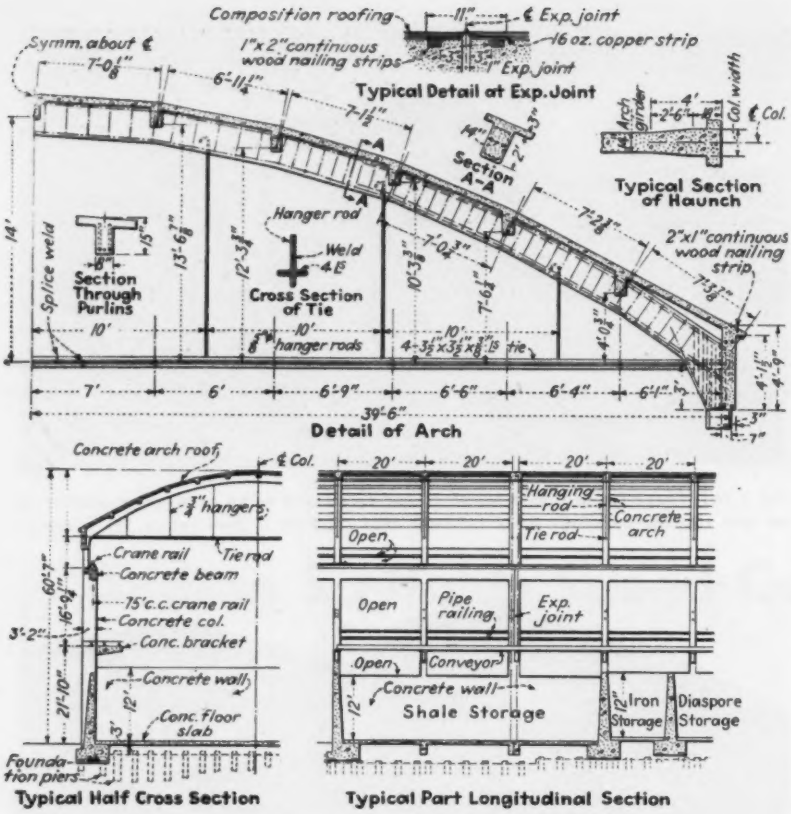


Fig. 4. Details of the concrete framing used in the raw storage building.

An interesting feature of handling reinforcing for the high main columns is to weld the entire bar assembly for each column into a rigid cage that can be erected easily. Floors, retaining walls and hoppers are built in each section after the shell is completed and the scaffolds moved.

Other plant features

Parallel and adjacent to the raw materials storage building is a new raw mill building, 240 ft. long, 72 ft. wide and 55 ft. high. This is a totally enclosed building of the same general construction as the raw materials storage building. It will contain preliminary grinding units, raw tube mills, slurry and admixture tanks, and the necessary auxiliary equipment.

The slurry storage and mix control system consists of eight 25½-ft. dia. and four 15-ft. dia. concrete tanks, 39 ft. high. The smaller tanks will be used for high lime, high iron, high alumina, and high silica slurries, and will also be of service when producing special cement. The larger tanks will have slurry capacity sufficient for four days of kiln operation.

Third in the new group of structures is the kiln building, 635 ft. long, varying from 30 to 45 ft. wide, with an average height of 47 ft. The feed and cooler ends and that portion of the building adjacent to the raw mill are enclosed, the side walls being omitted for other portions. All closed parts of the kiln building are mechanically ventilated. This building houses the kiln, clinker cooler, coal preparation machinery, kiln feed mechanism and departmental auxiliaries. The kiln will be 475 ft. long, 11½ ft. in dia. It will have a slope of $\frac{7}{16}$ in. per ft., and will rest on seven sets of carrying rolls. The kiln will be completely lined, partly insulated and equipped with 19,600 lin. ft. of ⅝-in. chain extending over 105 ft. of shell in the drying zone. A motor-driven Ferris wheel operating through a synchronous tie with the kiln motor and speed changer, will control the feed.

A fan of 150,000 cfm. capacity will handle the exit gases. Clinker will discharge into an air-quenching type cooler with a grate length of 100 ft. Because of foundation and structural conditions, the cooler was placed continuous with the kiln, which accounts for the great length of building required. A novel feature of the kiln and cooler installation will be an air-jacketed kiln end and an air-jacketed seal. The parts subjected to high temperature will be of heat-resistant steel, and air for cooling purposes will be supplied by an independent blower unit. Because of the characteristics of the new kiln and consequent low temperature of the exit gases, no provision will be made for waste heat recovery. To compensate for this condition, a 450-lb. pressure, 55,000 lb. of steam per hr. boiler, with all necessary auxiliaries, will be installed in the power department.

The silo warehouse, built in 1933, with a capacity of 150,000 bbl. will be retained. The original warehouse, though obsolete, will continue in service for the present as an overflow storage. Eventually it will be replaced with a modern structure, packing plant and bag-handling equipment. Shops, storeroom and laboratory, all housed in one structure, will be retained in use without major alterations. Additional shop equipment was installed during the past year. The chemical and physical laboratories were completely modernized and rebuilt a short time ago. Construction will start shortly on a modern office building, which, in addition to the plant offices, will contain locker and bath facilities for all employees. Architectural concrete will be used throughout.

Operations at the quarry have been improved and modernized. Stripping, done by contract, amounted to

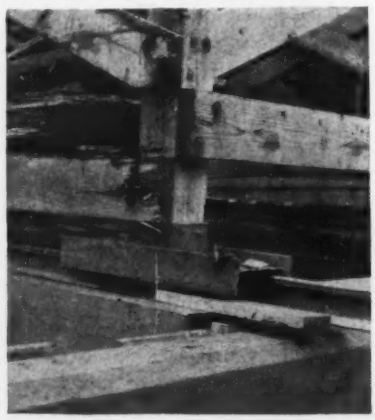


Fig. 5. Sliding steel shoes move scaffolds ahead on rails carried by low cribbing. There are two rails under each set of shoes; one rail is hidden here by the shoe.

638,000 cu. yd. during the past year. Sufficient overburden is removed at each operation to uncover a two or three-year supply of limestone. Face drilling is carried out by a special tractor-mounted, diesel-driven, unit that carries two air compressors and two 4-ft. derrick drills on universal supports. Stone is loaded by a 2¾-yd. diesel shovel, and cars are spotted by tractor-mounted car puller.

A. F. Miller and G. J. Rahn of the Marquette Mfg. Co.'s engineering staff in collaboration with R. Moyle, Sr. and F. Moyle of the operating department, developed the plant layout, arrangement of equipment and process of manufacture to be used. J. L. McConnell of Chicago prepared the structural designs and architectural effects. Contract for the raw materials storage building, the kiln piers and installation of the kiln is held by Arthur H. Neumann & Bros. Inc., Des Moines; W. H. Miller is superintendent. Kucharo Construction Co., Des Moines, was awarded the contract for the raw mill structure, slurry tanks, kiln building, raw mill machinery foundations, sewer and water lines, and conveyor bridges. The boiler plant, except for the building, was designed by Cowham Engineering Co. in collaboration with F. Baumgardner, chief power engineer of the Marquette Mfg. Co.

Surveys Show Long Beach, Calif. Is Moving Up, Down and Sideways

PRECISE LEVELING carried on continuously before and after the Long Beach, Calif., earthquake of 1933, and especially during an 18-month period in 1940 and 1941, shows that an area including most of the city has been in more or less constant movement and has now taken a decided tilt downward in a southwesterly direction. The area involved is between the Wilmington and Inglewood fault lines which are about five miles apart. Maximum movement of about 0.8 ft. is made up of a 0.2-ft. rise at the northerly edge and a 0.6-ft. settlement near the ocean shore line. The following data has been supplied by the engineering department of the city of Long Beach.

A comparison of precise levels run annually has shown that various movements of the surface have been occurring, all of which are taken to indicate a progressive readjustment subsequent to the 1933 earthquake. In 1934 the tilt was 0.4 ft. at each end of Anaheim St., as compared to the elevations in 1931, and in 1938 a slight subsidence over the 1934 observations was found proportionally over the entire area.

Early in 1940 a first order level net was run over the entire city. This showed the whole area to be still moving, and that the rate of movement at the western end was twice that at the eastern end. In the latter part of 1941, in order to find what changes had taken place in the 18 months since the previous survey, portions of the 1940 net were re-run.

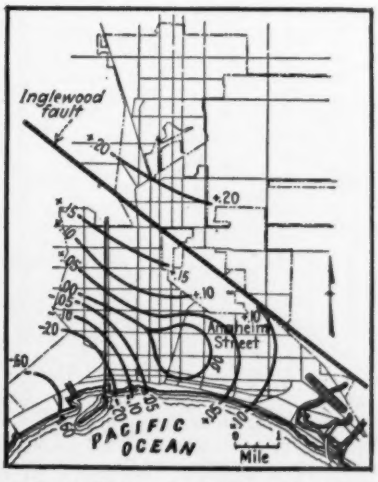
Comparison of differences in these observed elevations made 18 months apart, led to the conclusion that the settlement which had continued for some time after the earthquake had become a definite tilting movement over a considerable area. The latter of these two surveys shows the western end of this area to be still subsiding at a considerably increased rate, namely, a drop of 0.6 ft. in 18 months, while the eastern end during the same period showed a definite upthrust amounting to something more than 0.2 ft. A comparison of the two level nets also shows the direction of the tilt. These records of the 18-month movement are plotted in the form of isobase lines on the accompanying map.

The recent movements are taken to indicate that the block is again in unstable condition with stresses of an unknown nature building up. Under the elastic rebound theory this surface movement, if it continues, may be considered indicative of further seismic shocks incidental to readjustment, it is pointed out. Meantime, the Seismological Field Survey, U. S. Coast and Geodetic Survey, has installed a tiltmeter in Long Beach to determine frequency and intensity of the movements now going on.

In addition to the vertical tilt, the area has been undergoing horizontal displacement as well. This was discovered in 1939 when the Los Angeles county surveyor was unable to make final adjustment, in the Long Beach quadrangle, on the county-control triangulation net. He made a new series of observations, therefore, and precise checks showed the Long Beach area to have moved horizontally 0.2 ft. to the northeast. Thus it appears that as the tilting progresses, the block is also being pressed northward.

The precise leveling, as well as the accompanying sketches, were made under the supervision of J. R. McHenry of the Long Beach engineering department. Geo. E. Baker is city engineer and director of public service.

Location of Wilmington and Inglewood fault lines near Long Beach.



Isobase lines showing earth-surface movement during an 18-month period in 1940-41.

Work did not stop for winter. Pre-assembled window frames and studs cut to length can be seen piled in the foreground.

Housing Built on The Double-Quick

George Michelson
Vice President J. Slotnik Company, Boston, Mass.

Contents in Brief—*Detail planning, pre-cutting of material, pre-assembly of parts into easily handled units, and an inventory control system that assured delivery of the exact material to individual house units when needed, speeded the construction and cut costs on a Navy housing project. Careful detailing of each operation, plus the utilization of production line methods, permitted efficient use of semi-skilled labor.*

On A 600-Unit Housing Development to accommodate personnel at a Navy Yard, practically the only tool the carpenters used in the field was a hammer. The explanation of this unusual operation was complete pre-cutting of all lumber, each piece being plainly marked when cut and stacked near the fabrication yard. When the foundations were ready, the lumber for the floor of one building was hauled to point of use, followed, as required, by all the framing lumber and then by plumbing, roofing, and electrical materials. Trim and interior finish came to the work cut to size and was completely assembled in a job fabricating shop. Erection utilized production line methods, a crew doing only one operation on a house, then passing on to the next building.

Pre-cutting and assembly line techniques were adopted by the contractors to conserve material and to meet an expected shortage of skilled help in an area where little construction had been done in the last ten years. This solution of the labor problem was based on the expectation that an unskilled man would become efficient quickly by working at the same job day after day.

Before ground was broken the contractor analyzed carefully the operations necessary for construction, and agreed on 22 essential operations for the construction of the one-family units with only one more operation necessary for the double units. The next step was to estimate the number of man-hours required to perform each operation and select proper size crews to keep each portion of the work "in step." Sufficient crews were then organized to insure the desired overall progress on the project.

Field supervisory forces consisted of a general superintendent to whom an assistant general superintendent, the expediter and office manager reported. The assistant general superintendent held direct supervision over (1) field engineers (2) inventory control of warehouse and mill (3) assistant superintendents in charge of subcontract work and (4) operation superintendents directly responsible for several team captains in charge of small groups on the various essentials of construction.

One and two-unit houses

The 600 dwelling units of the development are made up of 150 single units, 24 ft. 4 in. x 28 ft., and 225 two-family units, 24 ft. 4 in. x 55 ft. 8 in. Each unit has a living room, kitchen, two bedrooms and bath. No basement is provided but full outside walls are carried below the frost line. A storage space 10 ft. x 10 ft. is floored in the attic with access through a 30 in. x 30 in. scuttle. Heat is oil-fired hot air, the heating unit (located in a kitchen alcove) supplying year-round hot water. Electricity is used for cooking and refrigeration.

Exterior walls are 2 in. x 4 in. studs at 16 in. centers with 1 in. wood

sheathing, building paper and creosoted wood shingles. Roofs follow the same pattern as the walls but use composition shingles.

Interior walls are ⅜-in. thick fiber board nailed to the studs, no other wall insulation being used; the ceiling is the same material but has insulating bats laid between the ceiling joists; walls and ceilings are painted. Double houses have special soundproofing in the party wall, the insulating strips being zigzaged between studs facing each way to entirely break the connection between the units.

The supervisory men responsible to the assistant general superintendent were in charge of certain operations only, rather than over a particular area or group of blocks in which houses were being built. The contractor's plan of operation was to follow as nearly as possible the straight line factory production methods except that the workmen move past the product in lieu of the product moving past the workmen. By organizing the work in this way, a minimum of non-working foremen were required. Within each group of men working on a particular operation was a team captain with twofold duties. First, he was responsible for maintaining the rate of progress established for his "team"; secondly, it was his responsibility to his team to make certain that their materials were at hand. The exercise of these duties kept the teams alert and active. Each man, after an operation was started, quickly realized his importance to his team; a "ringer" posing as a carpenter was quickly routed out by his teammates to better their production rate.

A system of inventory control was set up to conserve material and prevent waste. The inventory control served not only this function but also alleviated the unskilled labor situation by supplying all possible parts ready to use, thus substituting routine operation for general craft skill. In order to carry this out successfully, it was necessary that the proper amount of the materials required for each operation be made continuously available to the craftsmen. If workmen were obliged to look for a piece of lumber or were allowed to exercise choice in the use of lumber, this method of operation would have failed.

Pre-cutting material

A carpenter shop 150 ft. x 80 ft. was set up for the purpose of milling the framing lumber and building up such sections of each house as it appeared could be economically prefabricated. The mill was made of adequate size so that when the milling operations were nearly completed, the mill could be transformed into a suitable shop for pre-cutting the wallboard and also for the setting up of door frames and the hanging of doors and the installation of hardware.

At the time that the engineering staff divided the job into the various operations, full-size details of every piece of lumber going into the house were prepared. This was carried out even to the preparation of blocking for plumbing fixtures. The next step was to determine which members could be economically built up and delivered to the house location ready for installation.

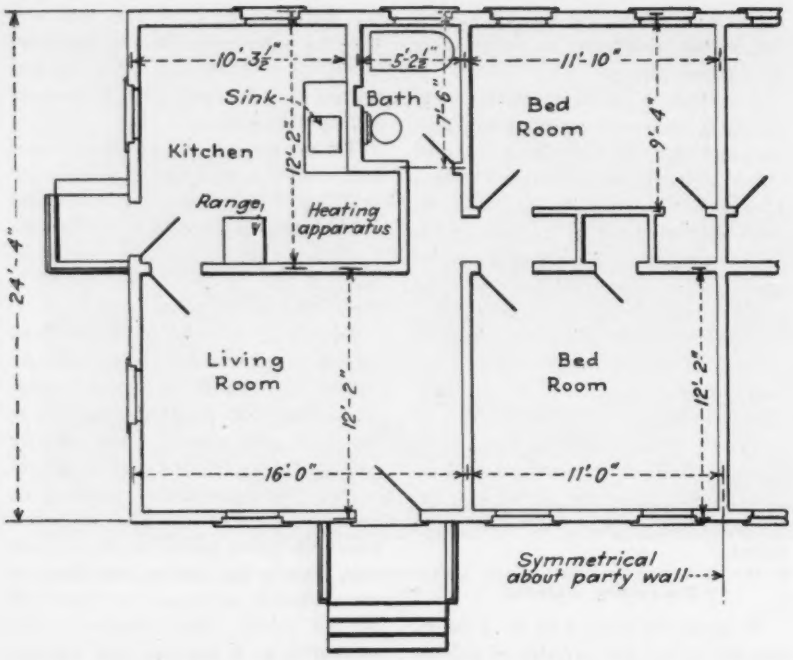
All the lumber was cut in advance and, where possible, partially assembled in the shop. Sills were cut for positions above and below windows and the short studs nailed to them in the proper length to fit in their marked position.

Incoming materials were received by a stock control supervisor who assigned them either to the warehouse or to the mill. Lumber assigned to the mill was placed upon gravity conveyors which fed two lines of radial-mounted circular saws. Each saw was set to make one cut, after which the piece passed on to the next saw. For a hip rafter the first cut was a double mitre on the front end of the piece, after which it was measured to a templet and marked for two straight bevel cuts on the opposite end and then passed to the next saws until all cuts were made. Each piece was marked to show its exact location in the finished work.

Construction procedure

Excavation for water and sewer lines and for the outside walls of each house was carried to a depth of 4 ft. Truck-mixed concrete was used for an 18-in. wide, 12-in. deep footing under the exterior wall with 18-in. square footings for the interior columns. Bricklayers then placed concrete block walls and columns to the height required to accommodate the building to the existing ground.

Care was exercised in locating these one-family houses on the site to take advantage of the rolling contour of the terrain. All existing trees were carefully protected during construction.



Floor plan of a two-unit house. The single-unit plan is similar except that one bedroom window is moved to what here is the party wall.

The material for a complete floor system was collected on a truck at the storage yard and hauled to the building site and piled—not dumped—as close to the work as possible. (Skids and tractors were used during the spring thaw.) The exact number of pieces of lumber required were taken to the work and if one was broken it was returned to the yard for replacement or, if taken for other purposes, a special explanatory requisition was issued. Unsatisfactory lumber was culled during the operations carried out in the carpenter shop. Savings in waste, in rehandling of material, and in reduced confusion are believed to have compensated for the few trips necessary to the storage yard for replacement material.

Floor framing was started by laying stringers over the center piers, followed by floor joists set in place at 16-in. centers and lapped over the center stringer. Bridging, already cut for quick handling, was nailed in place, followed by the sub-flooring, not pre-cut, which was placed over the entire area; the edges were trimmed with a portable electric saw. Necessary openings through the floor were cut later by a special crew.

As soon as the floor was laid the framing for the rest of the structure was brought to the site and piled so that material required first for construction was on top. The walls were assembled on the completed floor, the previously sawed-to-length studs, and sills with short studs, expediting the operation.

Following the same procedure there was delivered to each house the exact quantity of side wall and roof paper, asphalt roof shingles, creosoted wood shingles for side walls, including pre-cut wood shingles for gable rake, window frames, sash and wallboard. Doors were fitted, hung, and hardware installed at the mill so that they were delivered as a complete package to each house and the field work involved merely the erection of the unit in the rough opening left in the framing.

Some learned the hard way

The greatest difficulty the contractor experienced with the mechanics, who had never operated under this method, was that they were inclined to be lax in the use of the material delivered to them. It became necessary to post men in the field for a short time to stop the pilfering of 2x4 studs and similar material from the adjoining house to fill the void caused by the improper use of the lumber assigned to the house being framed. This practice of "borrowing" was stopped only after men and team captains were discharged for not following instructions.

Shipments of material from the warehouse or the lumber yard were made in accordance with definite schedules. Variations from the scheduled quantities were reported immediately, investigated and rectified. Use of this method of controlling materials proved that building mechanics can be trained to follow schedules; that waste can be eliminated; that the cost of maintaining the inventory control system is much less expensive than the cost of waste; and that, at no extra expense, rubbish can be greatly reduced.

The contractor for this $2,308,000 competitive bid project was the J. Slotnik Company, Boston, Mass. Albert L. Nelson was the general superintendent with David A. Kline as his assistant.

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Boundary Error Discovered

An error of a surveying party a century ago in locating the Texas-Louisiana boundary from the 32nd to the 33rd parallels of latitude has been revealed by the Louisiana Geodetic Survey, of which Lamar Acker is superintendent and William B. Benjamin cadastral engineer. The error placed in Louisiana a strip of land approximately 70 miles long and 100 ft. in maximum width. The strip involves ground in the towns of Latex, Lorraine, and Bethany, and the Rhodessa oil field, which straddles the present boundary. The 72 earth mounds erected with the original survey, which was conducted by Army Engineers through an almost impenetrable swamp, have been located. Examination revealed parchments enclosed in bottles buried in the mound.

This error brings all of the boundary between Louisiana and Texas into dispute because south of the 32nd parallel there is question as to where the boundary lies in the Sabine River. The 1819 treaty between Spain and the United States designated the west bank of the river north to its intersection with the 32nd parallel as the boundary, thence north to the 33rd parallel. This line was first surveyed in 1941. In 1856 an act of Congress fixing the Texas-Louisiana boundary set the boundary line at the center of the river. Louisiana plans to claim the strip north of the 32nd parallel on the basis of "acquiescence and estoppel," but it cannot so claim the strip in the river. Louisiana plans to attack the act of 1856.

Crane Rides Old Turntable To Prepare Pit for New One

A CRANE SWINGING AROUND on the old turntable was used to prepare a pit for a larger table at the Toledo, Ohio, yards, of the New York Central R.R. Big wrecking cranes were used to remove the old 90-ft. long table and set the new 115-ft one. The change was made necessary by addition to the railroad's rolling stock of the series 3000 locomotives, which are more than 109 ft. long over the couplings. The turntable is located in front of a division roundhouse where running repairs are made on all sizes of equipment; it serves five approach tracks and transfers to any track of the 27-stall roundhouse.

Installation of the new turntable required enlarging the pit to about $1\frac{2}{3}$ times its original size, driving piling for the circular rail support, and providing a concrete retaining wall for the pit, all of which was done under contract. The builder ran a locomotive-type crane on the old turntable and, by swinging the table to any desired location on the full circle, the crane was able to reach every part of the construction.

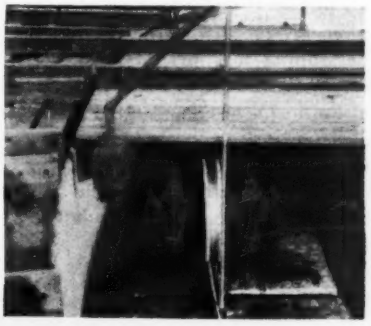
After excavation was complete, leads were hung from the tip of the crane boom and the crane used to drive the supporting piles. To support the outer ends of the new table 100 creosoted wood piles were driven in each of two concentric circles, one just inside and the other outside of the line of the 110-ft. dia. circular rail. The crane next assisted in setting pre-assembled sections of wood forms and then in placing the concrete, which was delivered to the job in transit-mix trucks. Short sections of steel channels embedded in the concrete serve as ties for the circular rail.

After the concrete work was completed the bridge crew of the railroad took over the construction, removing the old table, setting the circular rail, and installing the new table.

Temporary crib bridges were placed across the opening between the ends of the old table and the rail ends of the track as rearranged for the larger unit. The contractor's locomotive crane was run out of the work area and a railroad wrecking crane taken across the old table to the roundhouse side. The new table was brought out on the old structure on railroad cars and another wrecking crane brought up behind it. The two cranes set the 115-ft. table to one side and, following removal of the cars, lifted the old table to the other side. After the small amount of new work required to adapt the center support for the larger table was completed, the wrecking cranes set the big table in position and loaded the smaller one on cars for disposal.

The 115-ft. turntable was procured by the New York Central from the Cincinnati Terminal Co. who had purchased it for use in the remodeled Cincinnati Terminal but had never installed it at that point.

Contractor for the excavation, foundation and concrete work was Fritz, Rumer & Cooks, Columbus, Ohio, for whom Carl Brode was superintendent. E. W. Clayman, bridge supervisor, was in charge of the railroad's forces laying tracks and changing the structures, and F. A. Armull was resident engineer. J. W. Podmore is division engineer of the New York Central at Toledo; J. A. Stocker is district engineer, located at Cleveland, and George Harris is chief engineer.



A circular rail supports the outer ends of the table. No fastening device is necessary to keep the rails of the new table in line while locomotives move on.

The old turntable is kept in service to act as a swinging carriage for the crane while constructing a new turntable pit.

Rubble Masonry to Save Critical Materials

L. M. Winsor
District Engineer, U. S. Fish and Wildlife Service
Salt Lake City, Utah

***Contents in Brief**—Modern methods of laying up rubble masonry have greatly increased the efficiency and usefulness of this age-old type of construction. Since it requires no steel, a minimum of concrete and no mechanized equipment, it has a claim on engineers' attention in these days of scarcity and rationing. Each stone is laid as a header, with its thick end out and its inner end sloping downward. Large stones only are used. Voids are filled with coarse-aggregate concrete. An item of special interest respecting this article is that it was written on shipboard while the author was en route to the Middle East to serve as engineering consultant to the government of Iran. It was mailed from Singapore.*

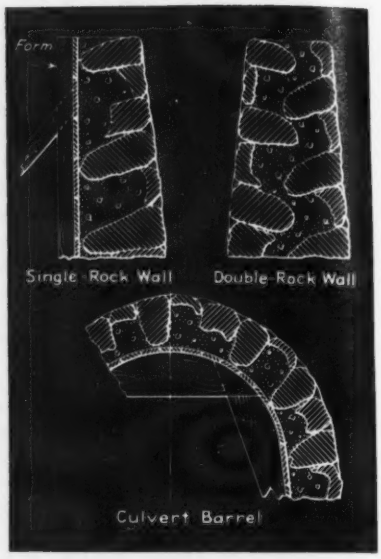


Fig. 2. How modern rubble masonry is laid up for different types of service.

In These Days of Emergency when some of our common materials are no longer abundantly available, engineers are faced with the alternative of developing new designs with substitute materials or of reverting to some of the forms of construction that were in use prior to the era of modern materials. Some of these early types of construction have forgotten advantages, and in some cases, unknown to most engineers, they have been improved until they are worthy competitors of so-called modern types of design for certain applications. A case in point is the rubble masonry that has been developed in the West during the past eighteen years. The method of construction and the resultant structure differ in several important respects from the old form of stone masonry and from the present common form of rubble masonry. The chief variations in this method of construction may be listed as follows:

(1) There is no mortar or concrete in the joints between rocks in the outer surface of the wall. The stones are fitted together as closely as possible, making sure that there are at least two good bearing surfaces on the exterior and one on the interior. Then the voids that remain under and around each rock are completely filled with good concrete of standard mix with plenty of coarse aggregates; the water used should not exceed 6½ gal. per sack of cement. A sloppy concrete is never used on any type of job.

(2) There is no coursing as in stone masonry and no selection of stones for face rocks. In ordinary practice strength and stability are sacrificed for looks, and each stone in the outer wall is placed with its best face on line and exposed to the outside regardless of stability. In the new type of masonry each stone is a header and is placed with the thick and to the outside. It is wedged down between two rocks already in position, with the long axis pointing inward and slightly downward, and is twisted and turned until it settles firmly into a position of stability. Then the voids around and under the inner end are completely filled with concrete. If there is room afterward for small stones on the interior of the wall they are crowded down into the fresh concrete to fill the wall more completely with solid stone. Spalls and small rock are never used as in

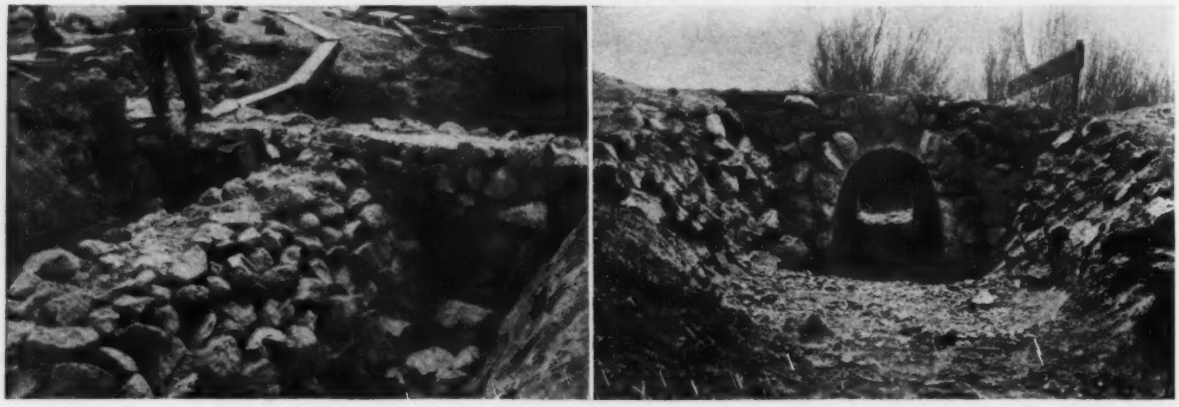


Fig. 1. Top and side views of a rubble masonry culvert. Note the relative absence of mortar on the exterior face.

Fig. 3. Building a rubble masonry wall using double-rock construction.

stone masonry to fill up the outer surfaces or to level up individual stones.

(3) There is no place on the new type of rubble masonry job for a stone mason of the old school or for his tools. He has too much to unlearn to be of service and he always slows down production because he wants to place every rock that is laid. No mortar of sand and cement, or sand, lime and cement is used, hence no need for a trowel; and since there is no attention given to a smooth, even outer surface, there is no need for a stone hammer. The work is laid to a line, but the uneven surfaces of each boulder project beyond the line; in other words the main bearings in the outer surface rather than the face, are kept on line.

Common labor and simple equipment

In place of the stone mason, common labor is used, and instead of one mason the work is divided among four individual crews. Experience has shown that it goes up more than four times as fast as the ordinary rubble wall built by skilled labor.

Out of any group of sixteen men the author has never failed to find at least four who could quickly qualify to lead the four individual groups. Each of these men takes a section of the job and places or supervises the placing of the boulders. The others bring up the rocks within easy reach and carry in the concrete and spade or tramp it into the voids on the interior of the wall or between the rocks and the inner form, as the case may be.

Concrete is not wheeled into the structure. Where wheelbarrows are used there is always a tendency to use too much concrete; excessive concrete tends to weaken the structure and raise the cost. The writer has found that common, heavy metal coal scuttles are best for carrying concrete from a mortar box where it is dumped from the mixer. Each time a scuttle is emptied it must be dipped into a tub of water so that concrete will not stick to the inner surface. With this precaution one set of scuttles will last for months of constant use. And this method of concrete delivery insures against the sloppy practice of scattering concrete on the outer face of the wall or structure. When the job is finished one should not see any concrete on the outer surface except in the larger corners where the stones may not fit snugly together. A one-bag mixer will keep four crews of men at work.

There is no longer any question as to the superior strength and stability of this type of rubble construction. During the eighteen years of experimentation and demonstration, hundreds of structures have been built throughout the West under a wide variety of conditions. Many of these have been subjected to the severest form of test. No failures have been recorded.

In one case a wingwall 35 ft. long and 3 ft. thick at the base, was built to a height of 34 ft. above streambed on an alluvial foundation. One end was tied into the crest of a flood-control spillway 25 ft. above streambed and the other end was curved into the bank. The space behind this wall was backfilled immediately by dragline, with muddy flood debris from the bottom of the streambed. Although this backfill material was soupy and exerted the greatest possible pressure, there was no sign of rupture or of overturning. A similar test was made on a 2-ft. heavily reinforced-concrete wall, and it broke in three places and shifted out of line 18 in.

In another instance a flood-control barrier a mile long was built across the mouth of a canyon. The spillway

Fig. 4. Rubble construction is suitable for relatively large types of projects such as the side walls of this spillway on a flood-control dam.

was located in the natural channel on alluvial fill and was raised in the first lift to a crest elevation 65 ft. above streambed. While construction was underway this structure was buried in flood debris, consisting of mud, boulders and huge rocks weighing many tons each. No injury to the structure was sustained. On the other hand a great benefit resulted because of the natural puddling effect upstream above the spillway and along the barrier, that was built out of loose gravelly soil. This barrier has since been raised to a height of 100 ft. above streambed in three successive lifts as the floods filled in the basin above, and provision is made for going still higher if needs be to check the floods and force the deposit of flood debris.

In another instance a group of engineers from Forest Service, Park Service and Biological Survey were inspecting a 5x5x150-ft. rubble masonry culvert that was nearing completion. To satisfy some skeptics in the group who questioned the stability of the structure, a tractor-bulldozer weighing 18 tons was driven to the middle of the culvert and turned completely around on its tracks. Careful examination failed to reveal the slightest flaw in the smooth surface of the interior of the barrel, even though the work was less than one day old.

Cost of rubble masonry

With respect to expense it has been proven time and time again that rubble of the best quality can be placed at the rate of 1¼ bags of cement per yd. of wall. One job, where a large number of culverts were built, averaging 4x4x40 ft., cement used averaged 42 bags per culvert including headwalls at both ends, or approximately one bag per lin. ft. of barrel.

Boulders were available on the site and the work was performed by CCC labor at the average rate of three days per culvert for sixteen men, or a total cost for labor at $3 per day amounting to $125. Other costs for equipment and cement did not exceed $50.

During 1935 the Bureau of Biological Survey completed nine large contract jobs in North Dakota and surrounding states under the immediate supervision of the writer. Each of these jobs included a large amount of rubble masonry of the type described above. The contract prices varied between $6 and $8 per yd. depending upon the distance covered in hauling the boulders, up to ten miles. Prices for reinforced concrete on these same jobs amounted to $15 to $25 per yd., and the contractors made more on rubble than on concrete.

A large industrial plant near Salt Lake City has installed, under the writer's general supervision, over 25,000 cu. yd. of rubble masonry on a force-account basis, using overflow or surplus union labor from the plant. On account of daily changes in personnel and foremen, the work was very inefficient. New crews had to be trained each time there was a turnover in men. Notwithstanding this handicap, and the expense of hauling the rock from the mountainside two miles away and a half to three-quarters of a mile above, this work was done at a cost of less than $12 per yd., sometimes running as low as $5 per yard including overhead.

Municipal Transportation Problems

EFFORTS OF A SCORE or more large cities to alleviate transportation problems piling up behind the war program are under observation by municipal transportation officials in all parts of the nation. Greatest interest is centered on programs for staggering opening and closing hours of factories, stores, offices and schools to spread out peak transportation periods.

Also considered or used, according to the American Municipal Association, are such methods as elimination of parking on streets used by buses and street cars, planned routes for defense workers and trucks, and utilization of "retired" street cars and buses.

Growing transportation problems are caused primarily by greatly increased employment, coupled with the tire-rationing program removing private cars from the highways and forcing workers to use public transportation systems. New defense industries aggravate the problem in many areas where transportation facilities hardly were adequate during normal times.

Among the cities where opening and closing hours for workers are spread over a period of several hours to level off transportation peaks, or where such action is under consideration, are Washington, D. C., Detroit and Pontiac, Mich.; San Francisco, Dallas, St. Louis, Atlanta, Chicago, Baltimore and Seattle.

The Washington plan was inaugurated last March when 75,000 government employees were put on staggered hours. Instead of coming to work all at once, they came at 15-minute intervals from 7:30 to 9:15 a.m. Closing hours were staggered accordingly. Recently the number of employees under the stagger system was increased to 200,000, and the spread in starting hours expanded from 7:30 to 9:30 a.m. Washington's 1941 bus and street car load was 22 percent more than the 1940 load.

Industrial Michigan is watching with interest two experiments to solve transportation difficulties. Detroit's city engineer is using a sample industrial area to work out a plan for staggering hours. The city's street railway system is using nearly 100 percent of its equipment in handling patrons during shift-change periods at the factories, but during the rest of the day "there is hardly any traffic about these plants." The rush periods also cause temporary abnormal demands on traffic police protection, which staggering of shifts would alleviate.

Pontiac recently began an experiment in mass conservation of automobiles, tires and gasoline under a plan worked out by the state highway department and Pontiac's labor and civic leaders. The program as outlined envisages increasing the loading of private cars from a ratio of 1.37 persons per car to four persons, staggered factory shifts allowing maximum use of buses by workers, walking instead of driving by private citizens, shopping during slack hours of bus use, and a possible change in school hours to allow children to use buses when traffic is light. The state council of defense is watching the experiment, which involves 26,000 workers in a city with a population of 66,000, with the intention of recommending it to other communities if successful.

Sewage Disposal For a Housing Project

Herbert Moore
Consulting Engineer
Milwaukee, Wis.

***Contents in Brief**—Unsatisfactory operation of individual septic tanks serving 40 houses of a suburban community led to the installation of sewers and a two-story type settling tank. The tank design provides some novelty in its arrangements for influent distribution, effluent discharge and sludge removal. Settled effluent is dispersed in sand and gravel deposits adjacent to the tank.*

In a Suburban Milwaukee, Wis., area now bounded by a sanitary district, forty homes were built two years ago and provided with septic tanks and gravel leaching beds. Household waste flow was above the average due to generous use of water, and soon the leaching beds overflowed. Nuisance resulted, including discharge of septic sewage on the ground surface. Also, due to back-pressure, plumbing systems were clogged, and an increased pumping load was imposed on basement sump pumps.

To alleviate these conditions residents of this area in Waukesha County promoted the formation of the "Westchester Sanitary District" under Wisconsin statutes, and constructed a system of sewers and disposal facilities. The manner in which the problem was solved may provide useful information on sewage disposal for small housing projects.

Analyzing the problem

The septic tank systems originally installed included a 300 gal. steel tank and 100 lin. ft. or more of gravel leaching beds. In general, the houses were equipped with only one bathroom. Laundry trays were provided in all basements, the waste water from which flows to a sump. No toilets were installed in the basements heretofore, because of the necessity of pumping all basement wastes. Floor and foundation drains also discharge to the sump. Automatic electric sump pumps discharged this waste directly to the gravel leaching bed.

Sanitary sewage from bathrooms and kitchen sink wastes flow by gravity directly to the septic tanks, which are located, in general, five feet from the houses, and thence discharge to the leaching beds.

At first, some interest was professed in constructing a drainage system to intercept septic sewage from all the over-burdened leaching beds and carry this effluent to the disposal site. It was held that this would be the shallowest and, therefore, the cheapest sewer system that could be built to correct the nuisance conditions. Furthermore, it would require no plumbing changes within the houses.

Objections to this plan were as follows: First, construction of the essential elements of a sewer system, namely pipelines and manholes would be required, and yet gravity basement drainage would not be realized and sump pumps would have to be maintained. Also it was believed that the collection of septic sewage might result in a major source of nuisance at the disposal site, in that septic sewage containing a large amount of dissolved organic matter would offer greater treatment complications than fresh sewage. Moreover, a plan of collection and disposal of septic tank effluent offered no precedent of having been successfully accomplished elsewhere.

Hence, the simplest possible plan of sanitary sewers was constructed to provide gravity basement drainage for all houses. House service lines were tunneled to the inside basement

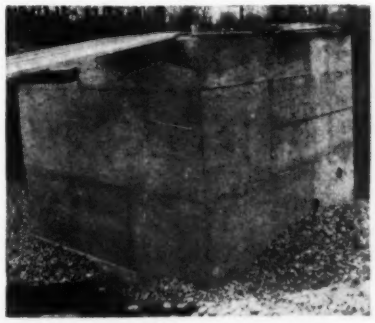
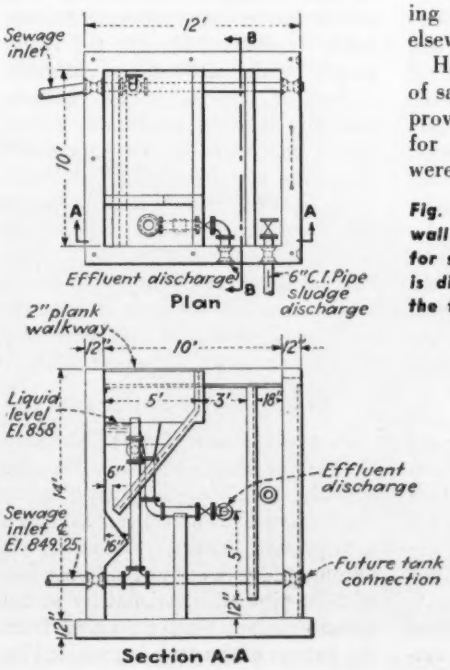


Fig. 2. Gravel backfill around the tank will facilitate dispersion of the sewage effluent.



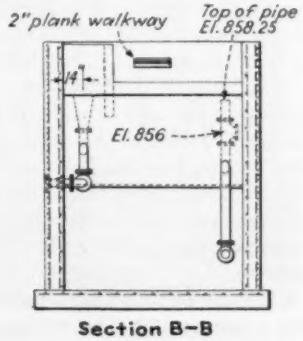


Fig. 1. Settling tank with a sloping baffle wall provides a separate compartment for sludge digestion. Incoming sewage is discharged against the end wall of the tank to still the flow.

wall lines, 18 in. below the floor in every case.

Although original plans indicated a minimum sewer grade of 3 ft. per 1,000 ft., a re-routing of the sewer permitted increasing this grade to 4 ft. per 1,000 ft., and thus better flow conditions and scouring action were provided.

All manhole covers were set 6 in. below ground surface and covered by earth or gravel to avoid their being a source of nuisance in the gravel roadways over which the district has no jurisdiction for maintenance. It was believed that exposure of the covers would result in maintenance troubles in grading, and interfere with snow-plow operations in the winter. Also, in cases where sewers were built in private easements, it seemed unnecessary to have manhole covers exposed in lawns or gardens.

Disposal plant design

The design of the disposal system was predicated on several environmental factors. These were:

Occurrence of natural beds of sand and gravel at the disposal site.

Sewage to be treated is fresh, reaching the disposal site after flowing through a relatively short system of collection sewers.

Sewage contained no industrial wastes that would complicate the treatment process.

The disposal site is adjacent to low-lying cultivated farmland. Surface drainage finds its way across the site to a drainage ditch about 1,000 ft. distant. Glacial moraine deposits of sand and gravel, encountered at the site, extend some quarter of a mile distant to gravel deposits formerly developed as commercial gravel pits.

A minimum of expense for disposal resulted from the decision to disperse sewage into the ground. A sedimentation tank was constructed for the removal of floating and settleable solids, and the liquid effluent is discharged through screened, coarse gravel. The gravel was backfilled around the tank to facilitate ground dispersion.

The tank is a "two-story type" settling unit, and it was designed primarily to serve the forty houses now in the district. To meet future requirements piping was installed for another tank, and recesses left in the concrete walls for keying-in a similar unit.

Present contributing population was taken as 120. The settling compartment provides for a flow of 60 gal. per capita for a 3-hr. displacement period, or for a total flow of 7,200 gal. per 24 hours. The sludge storage capacity is 408 cu.ft., thus providing 3.4 cu.ft. per capita. Anticipating groundwater and wet excavation difficulties in the construction of the tank, it was designed with a flat bottom rather than a hopper bottom or pyramid shape as otherwise might have been the case. This precaution proved wise because the fine sand encountered at the bottom of the excavation was extremely difficult to dewater.

Special provision in the tank is made for the relatively large quantities of floating solids anticipated from the fresh, non-septic sewage. No inlet baffle is included but the inlet line discharges against the end wall of the settling compartment, thus stilling the flow and allowing floating solids accumulation over the entire length of the settling compartment.

Another step taken to facilitate handling floating solids was to install a gate valve on the tank outlet line. This permits raising the liquid level so that accumulated material may be manually scraped over and into the sludge compartment. This valve also serves the purpose of building up head in the tank to provide additional hydraulic pressure for sludge removal.

Sludge removal simplification

Precaution was taken to simplify the task of sludge removal. Possible difficulty with clogged piping, under the limited hydraulic head available for gravity sludge discharge, is minimized by the use of only ten feet of 6-in. pipe laid horizontally at the ground surface. Sludge removal from the bottom of the tank is provided by means of a concrete baffle wall extending to an elevation one foot above the bottom.

For sludge removal, the sewer outlet valve is closed and the tank liquid level is allowed to raise about 2 ft. The sludge outlet valve is opened, and the hydraulic head forces the digested sludge under the concrete baffle wall, and out through the sludge discharge pipe.

The R. P. Kuehn Co. of Green Bay held the contract for the work, which was completed in 45 days. Design of the system and inspection of construction was handled by the writer. Commissioners of the Westchester Sanitary District are L. J. Klug, chairman, Ralph J. Gamber, and Harry L. Gunderson.

CONSTRUCTION COST BASED ON ESTIMATE OF QUANTITIES AND UNIT BID PRICES

Quantities	Unit Price	Estimated Cost	
900 lin. ft. 8-in. V. T. Pipe	0– 6 ft. cut at $1.00	$900	
1,800 lin. ft. 8-in. V. T. Pipe	6– 8 ft. cut at 1.15	2,070	
1,200 lin. ft. 8-in. V. T. Pipe	8–10 ft. cut at 1.30	1,560	
500 lin. ft. 8-in. V. T. Pipe	10–12 ft. cut at 1.50	750	
360 lin. ft. 8-in. V. T. Pipe	12–14 ft. cut at 1.80	650	
280 lin. ft. 8-in. V. T. Pipe	14–16 ft. cut at 2.10	590	
100 lin. ft. 8-in. V. T. Pipe	16–18 ft. cut at 2.50	250	
30 lin. ft. 8-in. V. T. Pipe	18–20 ft. cut at 3.00	90	
5,170 lin. ft. of 8-in. sewer		$6,860.00	$6,860.00
16 manholes at $75.00			1,200.00
2,200 lin. ft. of 6-in. sewer (house connections)			2,420.00
60 wyes at $3.67			220.00
Sedimentation Tank			1,500.00
Total			$12,200.00
Addition to contract for additional sewer installation			1,500.00
Final Total			$13,700.00

Groundwater Levels Rise in Kansas

Water levels in 215 out of 271 observation wells in central and western Kansas stood appreciably higher during the period October through December of 1941 than during the same period of 1940. Moreover, in response to the heavy rainfall in 1941, the water levels in 170 of these wells reached the highest stages during their periods of record. These figures released by the Geological Survey, U. S. Department of the Interior, represent one phase of groundwater investigations conducted in Kansas in cooperation with the Kansas Geological Survey, the division of sanitation of the Kansas State Board of Health, the division of water resources of the Kansas State Board of Agriculture, the city of Wichita, and the U. S. Soil Conservation Service.

Timber Frame Substation Saves Materials

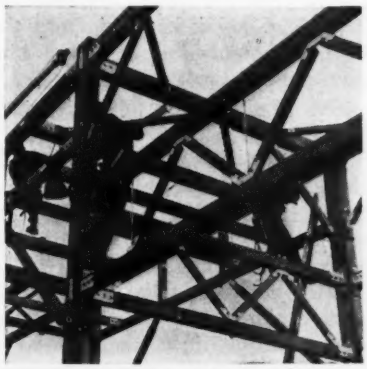
H. N. Fox
The Commonwealth & Southern Corp.
Jackson, Mich.

IN A DETERMINED EFFORT to conserve critical materials, such as steel and zinc, the Consumers Power Co. substituted treated timber for the usual galvanized steel frame on its new outdoor Black River sub-station near Zeeland, Mich. The station has three 24-kv. lines coming into it that serve two 3,000-kva. 24,000-7,500/12,000-volt, 3-phase transformers.

The structure is similar in arrangement to the conventional steel-frame station. All framing, including columns and trusses, is wood. Columns are fastened to concrete foundations through steel channels and anchor bolts. Unlike many former designs using wood poles and bolted timbers, this design produces a structure that is just as salvageable as one of steel should it be found necessary to move it to another location. Design loadings are the same as those for a similar structure of steel, and the timber actually provides a more rigid structure.

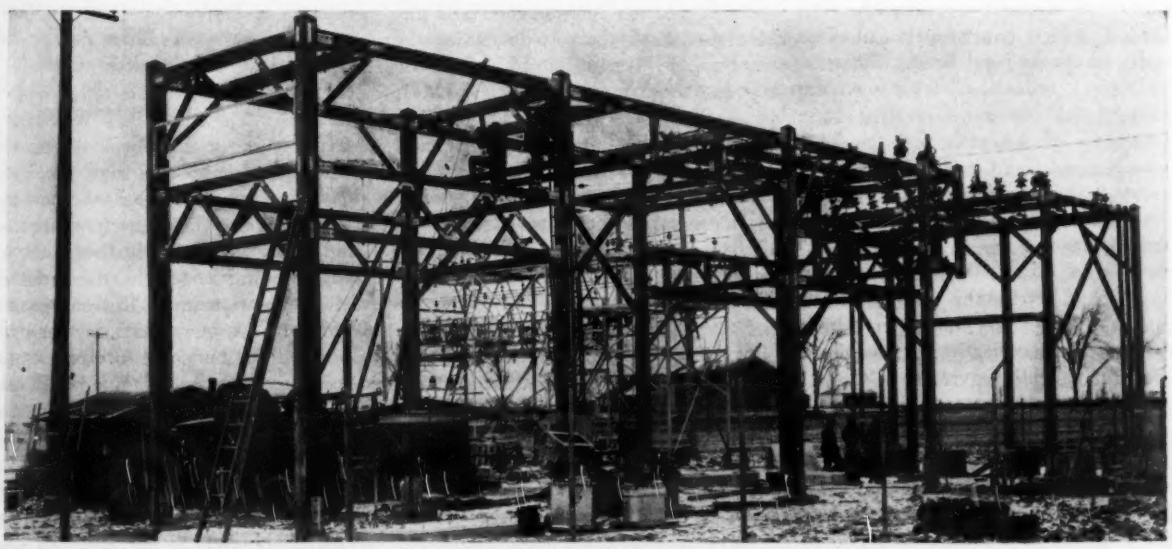
A select structural grade Douglas fir was used throughout. The structure was completely detailed, just the same as for a steel frame, and was completely fabricated at the shop, with steel plates and fittings for joints and attachments. It is largely through the proper design of the joints that the strength and rigidity of the structure depends. After fabrication, the timbers were treated with the new pentachlorphenol treatment, and an inexpensive tool using a pressure grease gun was designed for pressure treating all field holes. It is expected that the life will be 25 to 30 years, perhaps longer.

As the trusses and units had been shop assembled as far as possible, some small saving was made in field assembly as compared with steel structures of the same size. A new substation fabricated, but not yet erected, uses split rings, shear plates and connecting fittings, designed to reduce somewhat the quantity of steel and wood required. This results in a lap type of joint as compared with the butt type of joint used at Black River, and probably will not be quite as neat in appearance.



Details of the framing joints. Another type of wood structure, using split-ring connectors and shear plate, has been designed by the power company.

Although the wood structure was adopted principally to see what could be developed as a substitute for critical metals, it was found that material cost, delivered to the job, was 70 to 80 percent of the cost of steel. Of course, this will vary with the design and details, and principally with the voltage of the station. On low-voltage structures of approximately 15-kv. the wood tends to approach the cost of steel, and advantage in cost increase with the voltage. The structural wood substation will have a decided advantage in those areas where galvanizing deteriorates rapidly, as it will eliminate repainting as required on the galvanized structure. There may be a limit to the voltage that can be adapted to wood structures of this type (due to the spans required) and, at the same time, show a financial saving.



Treated timber replaces galvanized steel for an outdoor substation in Michigan. A life of 25 to 30 years is anticipated.

Supreme Court Sets New Precedent for Rate Regulation and Valuation Work

Contents in Brief—A decision that is expected to have a major effect on the valuation work of engineers and on utility regulation generally was rendered by the U. S. Supreme Court on March 16. In this decision the court made several significant pronouncements, the most important of which was that regulatory bodies no longer need follow the valuation procedure prescribed in the historic case of Smyth vs. Ames.

IN A DECISION THAT three Justices characterized as the start of "a new chapter in the regulation of utility rates," the U. S. Supreme Court, on March 16, said that rate-making bodies are not bound "to the service of any single formula or combination of formulas. Agencies to whom this legislative power has been delegated are free, within the ambit of their statutory authority, to make the pragmatic adjustments which may be called for by particular circumstances. Once a fair hearing has been given, proper findings made, and other statutory requirements satisfied, the courts cannot intervene in the absence of a clear showing that the limits of due process have been overstepped."

The case in question was brought to the U. S. Supreme Court by the Federal Power Commission and the Illinois Commerce Commission, seeking reversal of a decision of the Court of Appeals for the Seventh Circuit, which court had vacated an order of the Federal Power Commission for a reduction of rates on the part of the Natural Gas Pipe Line Company of America and the Texoma Natural Gas Co. The lower court vacated the commission's order on the ground that the commission should have included a "going-concern value" of $8,500,000 in the rate base it had set for the company, also that it erred in the manner in which it fixed the amortization period to be used in determining rates.

The Supreme Court, in its decision of March 16, reversed this action of the lower court. In a concurring opinion, Justices Black, Douglas and Murphy expressed the view that the opinion of Chief Justice Stone did not go far enough in telling the commission what it could do in the matter of rate regulation, while Justice Frankfurter, in a separate opinion in which he said that he wholly agreed with the Chief Justice, said "Surely, it is a usurpation of the commission's functions to tell it how it should discharge its tasks and how it should protect the various interests that are deemed to be in its and not in our keeping."

Origin of the case

The two companies involved in the case are engaged in business as a single enterprise, producing natural gas in Texas and transporting it by pipelines to Illinois where it is sold in bulk to public utilities. The Federal Power Commission, acting under the Natural Gas Act of 1938, issued an interim order to the two companies to reduce rates, pending a final determination of what their rates should be. For the purposes of this order the commission "accepted the companies' statement that the book cost of their property at the end of 1938 was $60,172,843, including working capital of $975,000; also that the value of all physical property—calculated at reproduction cost new (except for gas reserves taken on the companies' statement to have a present value of $13,334,775)— was $74,420,424, which the commission adopted as the rate base. It took the companies' own estimate of 23 years ending in 1954 as the life of the business, and for the amortization base used their cost figure of $78,284,009 for the total past and estimated future investment after deduction of estimated salvage. It calculated the 'annual amortization expense' on that amount for the 23-year period at a 6½ percent sinking-fund interest rate as $1,557,852, which it allowed." The Federal Power Commission also accepted the companies' estimate of prospective income available for amortization and return for the period 1939 to 1942, inclusive, as averaging $9,511,454 per annum, and after making allowance for higher income tax rates concluded that the companies' estimate of return, less the amortization allowance, exceeded the fair return, $4,837,328 (which is 6½ percent of the rate base of $74,420,424) by nearly $3,000,000. Taking into account the decreases in federal income taxes due to a decline in revenues, the commission decided that there was a total of $3,750,000 annually available for reduction of rates. It found the existing rates were "unjust, unreasonable and excessive," and in its interim order directed the company to file a new schedule of rates effective Sept. 1, 1940, which would bring about an annual reduction of $3,750,000 in operating revenue.

As noted previously, the circuit court set aside this order because "going-concern value" was not included in the rate base, and because the amortization period, instead of the full 23 years estimated life of the business, should have been dated from the passage of the act or the time of the commission's order.

Scope of judicial review

In reversing the lower court, the Supreme Court said that the only question before it was whether the rate prescribed by the commission was too low. It said, further, that by long-standing usage in the field of rate regulation the "lowest reasonable rate" is one which is not confiscatory in the constitutional sense. Assuming that there is a zone of reasonableness within which the commission is free to fix a rate varying in amount and higher than a confiscatory rate. . . . the commission is also free under Section 5a [of the Natural Gas Act] to decrease any rate which is not 'the lowest reasonable

rate'. It follows that the congressional standard prescribed by this act coincides with that of the Constitution, and that the courts are without authority under the statutes to set aside as too low any 'reasonable rate' adopted by the commission which is consistent with constitutional requirements." Then followed the statement quoted in the opening paragraph which, presumably, refers to the decision in the case of *Smyth vs. Ames*, which has largely controlled the rate regulation and valuation work since it was enunciated in 1898. That decision said, in part:

> And in order to ascertain fair value the original cost of construction, the amount expended in permanent improvement, the amount and market value of its bonds and stocks, the present as compared with the original cost of construction, the probable earning capacity of the property under particular rates prescribed by the statute, and the sum required to meet operating expenses, are all matters for consideration and are to be given such weight as may be just and right in each case.

Going-concern value

Commenting on the omission of $8,500,000 of going-concern value by the commission in fixing the rate base, the courts said that the commission, in establishing the rate base, "reluctantly" accepted the companies' own estimates of the value of its properties and that while no item for going-concern value was separately stated, "the computation of cost new of physical equipment included—in addition to labor and cost of materials—large amounts for overhead, interest, taxes, administration, legal and supervisory charges, and expenses paid or incurred in assembling the plant as that of a going concern." The court noted that the going-concern value claimed by the companies included expenditures for securing new business, interest on money invested in non-productive plant capacity, taxes paid on non-productive capacity, fixed operating expenses attributable to non-productive capacity, and depreciation of non-productive capacity. "The companies' contentions with respect to all these items are predicated upon the limited life of the business, 23 years, and on testimony that in anticipation of its growth, larger gas mains and facilities were constructed than were required during the earlier years of business. The reproduction cost new of this excess of equipment is admittedly included in the rate base." The court characterized these as "synthetic figures," and noted that they appeared to have been paid out of current earnings, and then went on to say, "There is no constitutional requirement that going concern value, even when it is an appropriate element to be included in a rate base, must be separately stated and appraised as such. This court has often sustained valuation for rate purposes of a business assembled as a whole without separate appraisal of the going-concern element. . . . When that has been done the burden rests on the regulated company to show that this item has neither been adequately covered in the rate base or recouped from prior earnings of the business".

Amortization base

On the question of the amortization base used by the commission, the court said, "The Constitution does not require that the owner who embarks in a wasting-asset business of limited life shall receive at the end more than he has put into it. We need not consider whether, as the government urges, there can in no circumstances be a Constitutional requirement that the amortization base be the reproduction value rather than the actual cost of the property devoted to a regulated business. . . . It is enough that here the business, by hypothesis, will end in 1954, and that the amortization base, computed at cost and including property already retired, will be completely restored by 1954 by the annual amortization allowances.

On the matter of the length of the amortization period, which was raised by the lower court, the Supreme Court said: "Here there is no question but that the commission's annual amortization allowance, if applied over the entire 23-year life of the business, is sufficient to restore the total capital investment at the end, or that earnings of the past and those estimated for the future, together, are sufficient to provide for the amortization allowance and a fair return, given an appropriate rate base and rate of return. Making that assumption we cannot say that adequate provision has not been made for restoration of the companies' investment from earnings and a fair return on the investment."

"The commission found that '6½ percent is a fair annual rate of return upon the rate base allowed,' which it had characterized as a generous allowance. The courts are required to accept the commission's findings if they are supported by substantial evidence. We cannot say on this record that the commission was bound to allow a higher rate."

More freedom sought

Justices Black, Douglas and Murphy, in their concurring opinion, said, in part, "Congress has provided in Section 5 of the Natural Gas Act that the rates fixed by the commission shall be 'just and reasonable.' The provision for judicial review states that the 'finding of the commission as to this fact, if supported by substantial evidence, shall be conclusive.' But we are not satisfied that the opinion of the court properly limits the scope of that review under this act. Furthermore, since this case starts a new chapter in the regulation of utility rates, we think it important to indicate more explicitly than has been done the freedom which the commission has both under the Constitution and under this new statute. While the opinion of the court erases much which has been written in rate cases during the last half century, we think that this is an appropriate occasion to lay the ghost of *Smyth vs. Ames* which has haunted utility regulation since 1898.

"Prudent investment" advocated

"Mr. Justice Brandeis, in the *Southwestern Bell Telephone* case, demonstrated how the rule of *Smyth vs. Ames* has seriously impaired the power of rate regulation and how the 'fair-value' rule has proved to be unworkable by reason of the time required to make the valuation, the heavy expense involved, and the unreliability of the results obtained.

"As we read the opinion of the court, the commission is now freed from the compulsion of admitting evidence on reproduction costs or giving any weight to the element of 'fair value.' The commission may now adopt, if it chooses, prudent investment as a rate base—the base long advocated by Mr. Justice Brandeis. And for the reasons stated by Mr. Justice Brandeis in the *Southwestern Bell Telephone* case, there could be no constitutional objection if the Commission adhered to that formula and rejected all others."

Asphalt Cutoff Wall at Claytor Dam

H. S. Slocum
Construction Engineer
American Gas & Electric Service Corp., New York

***Contents in Brief**—A cutoff wall of a sand-asphalt mix was used at the Claytor hydroelectric project near Radford, Va., to stop underflow through the north abutment of the dam. A sheeted trench was sunk through the overburden to rock, and, after all solution channels had been cleaned out, the trench and all rock channels were filled with the hot sand-asphalt mix to above reservoir level.*

ONE OF THE CHIEF PROBLEMS faced in construction of the Claytor hydroelectric project on the New River near Radford, Va., was development of a method for checking underflow through the north abutment, which consists of a dolomite rock, badly cut by solution channels and overlain with rock fragments and clay. The problem was met by the novel expedient of filling a cutoff trench with a hot sand-asphalt mix, as described briefly in the general article relating to the Claytor project in *ENR*, March 13, 1941, p. 392. Because this is the first major application of asphalt to cutoff wall construction, the following details of the work are given.

Before starting construction, intensive drilling operations were carried out across the north abutment to locate the existing water-table contour at a point 4 ft. above the projected pond level of El. 1,846. A consistent water table at that level was not found until about 600 ft. back from the dam, making it evident that the rock grouting for the dam foundation would have to be extended to that point if a tight seal was to be obtained.

Locating the ceiling line

As the rock cliff, into which the north end of the dam is keyed, disappears underground a short distance beyond the crest of the slope, a large amount of exploration was necessary before sufficient information could be obtained for locating the sealing line in the most satisfactory position. The abutment first was spudded in an effort to obtain the depth of the overburden, but as the results were inconclusive, it was decided to uncover the rock on a line which the spudding operation showed to be the most favorable. This work resulted in a sheeted trench 340 ft. long, averaging less than 4 ft. wide and ranging from a few feet to 150 ft. deep.

The overburden was found to be residual clay containing some beds of water-borne gravel and a few boulders. Below the clay the rock was a yellowish gray dolomite stratified with shale containing bedded chert.

The cause of the seemingly inconsistent results obtained by spudding was revealed when the rock was uncovered. Due to solution, the elevation of the rock surface was extremely variable and the formation contained many water passages and deep pockets filled with clay which had to be excavated.

The surface of the rock was below El. 1,850 (4 ft. above pond level) for a distance of about 255 ft., and, as there was some doubt as to the ability of the overburden to resist excessive seepage, it was decided to backfill the trench below El. 1,850 with some impervious material. Reinforced concrete was at first proposed but was rejected for the following reasons: Reinforced concrete lacks flexibility and would have been very expensive and difficult to place because of the narrow width and great depth of the trench. The use of reinforced concrete would have required the removal of the trench tim-

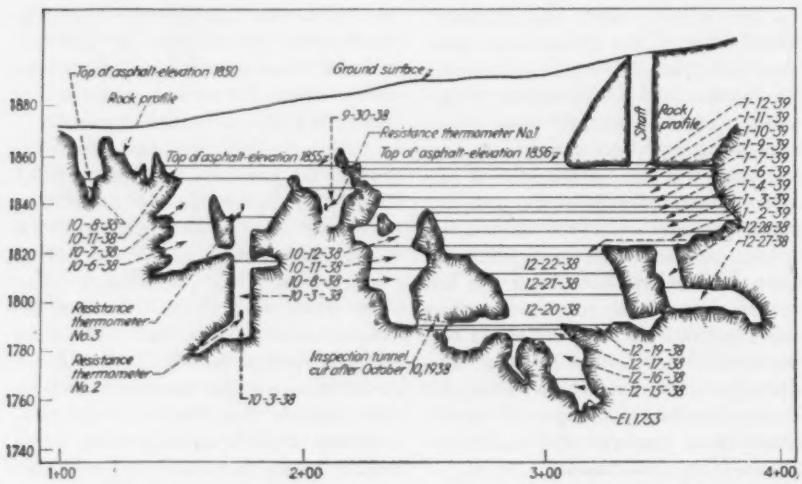


Fig. 1. Section through the cutoff trench showing the extent of the solution channels in the rock. Dates on which the asphalt pours were made are indicated.

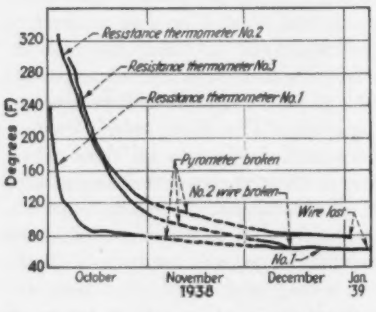


Fig. 2. Temperatures recorded by the resistance thermometers installed in the sand-asphalt mix at the points indicated on Fig. 1.

Fig. 3. Interior of one of the many large solution passages that were cleaned out and filled with asphalt.

Fig. 4. The character of the hot mix as it went into the cutoff is indicated by this picture of a truck discharging into the trench.

bering, which had been in place for many months. Although the timbering was strongly braced, there was sufficient "working" of the members to indicate that it was sustaining heavy pressures, hence its removal would have been an extremely hazardous undertaking. Puddled clay was also considered, but its placing had some of the objectionable features of reinforced concrete, particularly as it too would require the removal of the timbering. After much thought the idea of using asphalt was evolved, and it proved to be the material best suited for the purpose from the standpoint of effectiveness, desired flexibility, economy, ease and safety of placing.

As there was no record of asphalt having been used as a corewall material in a dam previous to this time, The Asphalt Institute was consulted and asked to design a mixture of asphalt and aggregate which would remain permanently "rubbery" and flexible at 56 deg. F., the approximate constant temperature of the earth at the depth which the diaphragm would be buried. A flexible diaphragm would adjust itself to any of the forces caused by settlement and movement of the ground to which it might be subjected without cracking and, having this autogenous characteristic, it would seal any leaks which might occur in the future due to solution of the rock surface upon which it rested.

After experimenting with various sizes and gradings of aggregate, the institute recommended the following specifications for asphalt and aggregate in the proportion of 11½ percent to 88½ percent. (Dolomite sand was specified as it was manufactured on the job.)

ASPHALT

Specific gravity	1.015
Softening point	105 deg. F.
Penetration (77 deg. F.)	190
Furol viscosity (210 deg. F.)	916 sec.
Flash test	620 deg. F.

DOLOMITE SAND

	Percent by weight
Passing ¼ in. retained on No. 10 sieve	19.5
Passing No. 10 sieve retained on No. 40 sieve	39.5
Passing No. 40 sieve retained on No. 100 sieve	16.5
Passing No. 100 sieve	24.5
	100.0

The placing of the mixture was very simple after the following preliminary work had been performed: A standard premix plant, such as is used for highway work, with asphalt heater, aggregate drier, batch weigher, mixer and tanks, was set up at the site. The old wooden trench braces were removed without disturbing the sheeting and replaced with steel pipe jacks which were made in various lengths on the job. (The jacks, which were filled with cement grout to prevent the passage of water through them, were to be left in place.) The surfaces of the rock were wire brushed and primed after the trench had been thoroughly cleaned of all foreign matter.

Weighed batches of dried sand and heated asphalt were mixed for three or more minutes at an average

Fig. 5. Rock surface exposed in a small exploration tunnel showing how asphalt was forced into cracks in the rock adjoining the cutoff for a distance of several feet from the core.

temperature of 335 deg. F. and the mixture was taken in tight-bodied trucks to the trench and dumped in suitably placed hoppers which discharged vertically.

Inasmuch as the mixture stayed in a liquid or semi-liquid state for some days after it was poured, it was possible to pour the asphalt mixture at a rate governed only by the physical demands of the work. It was not necessary to limit the height of pours because of laitance formation or construction joint as would have been the case had concrete been used. The pressure caused by the weight of the high lifts, as well as the weight of succeeding pours on the fluid mass, not only compacted the mixture in the trench but forced it into all of the surrounding spaces to the point of completely embedding the sheeting. The solution passages were so tightly packed with the asphalt that no air pockets remained and even the small cracks in the rock were filled for some distance from the trench. This was demonstrated by a small inspection drift which was driven a short distance through the rock to a section of the completed diaphragm and also by diamond drills which later encountered stringers of the asphalt several feet from the trench.

Resistance thermometers were placed in the asphalt and a record was kept of the daily readings until the wires were lost. As the temperatures had closely approached normal by that time, no effort was made to continue the readings and the trench was backfilled with clay from the top of the asphalt to the ground surface.

In all, 4,470 tons of the mixture were used in the making of the diaphragm.

Design and supervision was by American Gas & Electric Service Corp., Philip Sporn, vice president and chief engineer, H. A. Kaufmer, construction engineer, F. W. Schneidenhelm, New York, consulting engineer, and the author in charge in the field.

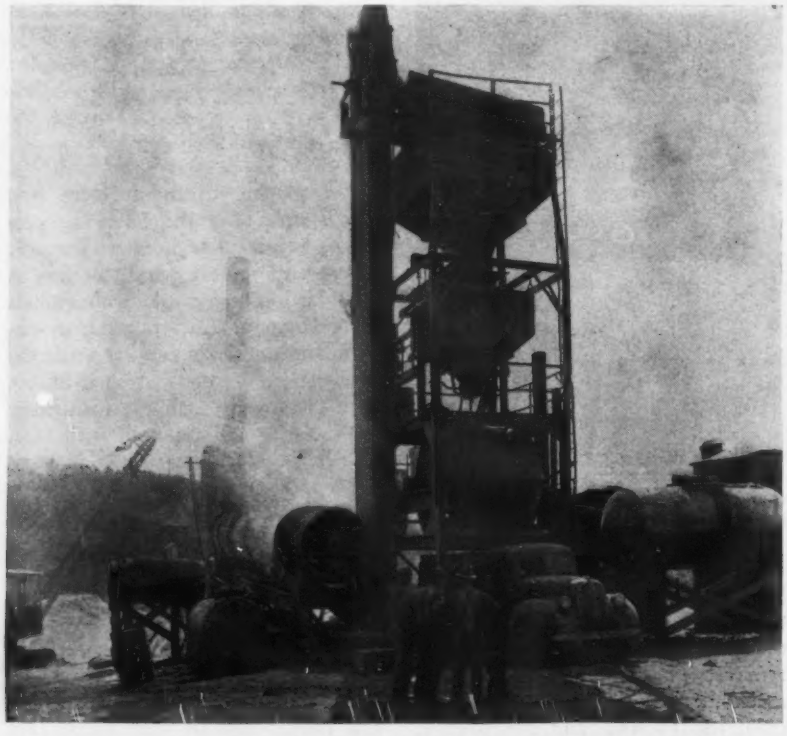


Fig. 6. Asphalt plant used to make the hot sand-asphalt mix for the cutoff.

Softening Surface Water At Kankakee, Ill.

One of the few lime-and-soda softening plants in Illinois that treat surface waters is that of the Kankakee Water Co., some notes on which are given by H. D. Clark, chemist for the company, in *Over the Spillway*, the official bulletin of the Illinois State Department of Public Health. The water is taken from two streams: that of the Kankakee River is hard, coming from a limestone formation, while that of its tributary, the Iroquois River, is very soft but has high turbidity after rains, owing to the bed of the stream being muddy.

With raw water averaging 20 grains of hardness (60 percent carbonate and 40 percent non-carbonate) the company is under contract to furnish a supply having only 4 grains hardness (generally 2 grains of each kind). As the hardness fluctuates rapidly, the operator has to be alert in order to maintain 2 grains of non-carbonate hardness. At each hour of the three 8-hour shifts the operator takes eight samples: (1) from the raw-water pump; (2) effluent of first reaction basin, as the control point of lime dosage; (3) effluent of third reaction basin, for soda-ash control; (4) effluent of clarifier; (5) recarbonization basin, for control of carbon dioxide; (6) top of filters; (7) below the filters, to insure clean water flow to the clear well, and also to control the chlorine dosage; (8) a final sample from the tap.

Altogether there are 217 tests during the 24-hour day, of which 188 are for phenol and total alkalinity, 13 for non-carbonate hardness, and 16 for residual chlorine, turbidity, color, taste, odor and soap hardness. In addition, bacterial examinations are made daily from three points at the plant and two on the distribution system. Mr. Clark explains that while all this program might seem to be unnecessary, it is easier to treat the water when it is in the plant than after it has finally reached the clear well.

Finding Moisture Content of Soil By Water Displacement Method

Allen S. Cary
Assistant Geologist

Boyd H. Walter
Junior Engineer

U. S. Engineer Department, Seattle District

Contents in Brief—A method by which the moisture content of granular soil going into an earth dam can be determined within the desired limits of accuracy was developed in the soils laboratory at Mud Mountain Dam in Washington. Determinations can be made in less than ten minutes after the apparatus has been calibrated.

A METHOD of accurately determining the moisture content of soil samples in less than ten minutes, where only granular materials are involved, was developed and used in the field and in the laboratory at Mud Mountain Dam near Seattle, Wash. Endeavor to develop such a method was begun when it was found that the means of testing ordinarily used had serious limitations that were particularly objectionable on this job. Comparative tests indicated that results with the new method are fully as reliable as those obtained by methods in common use.

The objection to determination of moisture content by standard oven drying at 110 deg. C. was that final results were not available for 12 to 18 hr., thus making the determination of limited value as a means of field control or laboratory testing. The quick-dry method, on the other hand (in which samples are dried at high temperature), gives results in 15 to 20 min. but involves chemical alteration and losses of organic materials and film moisture that render results unreliable.

In searching for a better method, attention was given to moisture determination by the displacement method used on concrete aggregate (outlined in U. S. Bureau of Reclamation concrete manual, Mar. 1939, p. 311). Fundamentals assumed as the basis for this development were that a certain weight of water occupies greater volume than the same weight of soil. The greater the amount of water in a given weight of soil, the greater the volume of the sample. Therefore, the volume displaced by any soil sample is directly proportional to the moisture content.

It was recognized that the displacement method, if applicable at all, would have to be limited to cohesionless materials. The degree of accuracy would depend on (1) the quantity of air trapped in the various samples and (2) the variation in specific gravities of a series of samples. For the apparatus developed at Mud Mountain, a 900-gram sample of material passing a ¼-in. screen has been found most convenient and practical. This 900-gram sample is more truly representative of the material than ordinary 100-gram oven-dry samples.

For any given weight of soil, the volume of water displaced is proportional to the original moisture content of the sample and if the apparatus has been calibrated, this moisture content can be read directly from a calibration chart.

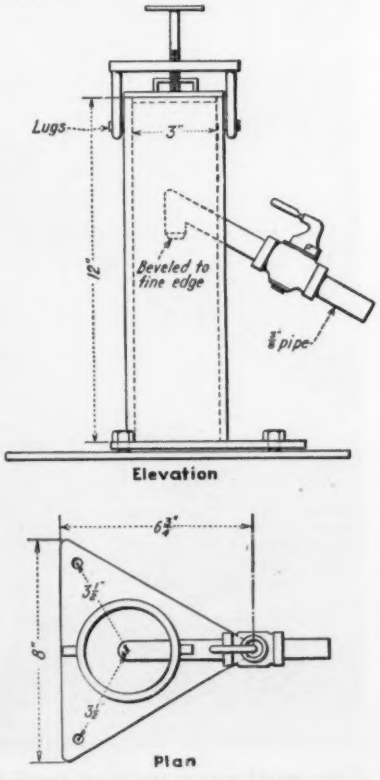


Fig. 1. Details of apparatus for measuring displaced moisture.

In calibrating the apparatus, 300 moisture determinations were made on samples taken in triplicate. For each three-sample group one moisture determination was made in the apparatus using the new method and two were carried out by the standard oven-dry method. The average moisture content in the two over-dried samples was plotted against the volume displaced with the results shown in Fig. 2. Determinations with the new apparatus were found to check oven-dried samples to within plus or minus one percent in 98 percent of the tests. This is within the limits of accuracy of the oven-dry moisture method.

To determine an average specific gravity for the material used in the Mud Mountain Dam core, tests were made on more than 60 samples. These were found to range from 2.69 to 2.75 and the average was 2.72. A variation of 0.03 in specific gravity introduces the same change in results as a variation of one percent in moisture content. The theoretical displacement curve for specific gravity of 2.72 is shown dotted on Fig. 2. This could be used as a calibration curve without introducing an appreciable error, especially within the moisture range at which material was being placed in the Mud Mountain Dam core.

Based on these considerations, the apparatus developed for the new determination method uses a cylinder made of a 12-in. length of galvanized iron pipe 3 in. in diameter and closed at the bottom by a triangular plate which is welded on. The top of the cylinder is fitted with a cover to make a water-tight joint. A siphon of ⅜-in. pipe fitted with a stopcock is exactly centered in the cylinder. The triangular bottom plate has three legs which rest in corresponding indentations in a brass plate used as a base. This apparatus can be constructed in any small machine shop for about $15.

In making the moisture determinations, the cylinder is filled with clean water to a depth sufficient to start the siphon. The stopcock is then opened and water is drained off until the siphon breaks; the valve is now closed, a 900-gram sample is placed in the cylinder and the lid is clamped on. The cylinder is then shaken for one minute to release entrapped air from the sample. On replacing the cylinder on the base plate in the same position as before, the lid is removed,

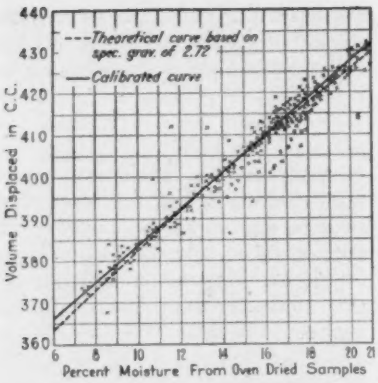


Fig. 2. Chart for determining moisture percentage when volumetric displacement of 900-gram sample is known.

the valve is opened and the displaced water is drained into a measuring flask. For any volume of displaced water, measured in cubic centimeters, a corresponding moisture content, in percent, can be read directly from Fig. 2.

This new apparatus was used throughout the construction of a test fill and in field tests of moisture content during construction of the core zone in the dam. Because the results were found to be as accurate as in oven-drying tests, it was later used for determinations in the laboratory as well as in the field. The complete operation in making a moisture determination, including taking the sample, screening, running the test, and reading the moisture from the chart, requires less than ten minutes time.

For convenience in fill control, calibrating a Chapman flask to read moisture content in percent direct may be found practical. Another possible application of the apparatus is mechanical analysis determinations as outlined in *E.N.R.* Feb. 27, 1941, p. 68.

Samples of alluvial soils from three other sources have also been tested with this same apparatus. The degree of accuracy in these tests has been as good as those reported on the Mud Mountain Dam job. The method is believed to be applicable to any cohesionless material which has a fairly constant specific gravity.

The authors were chief and assistant chief, respectively, of the soils laboratory at Mud Mountain Dam, U. S. Engineer Department Flood Control Projects, which is now nearing completion.

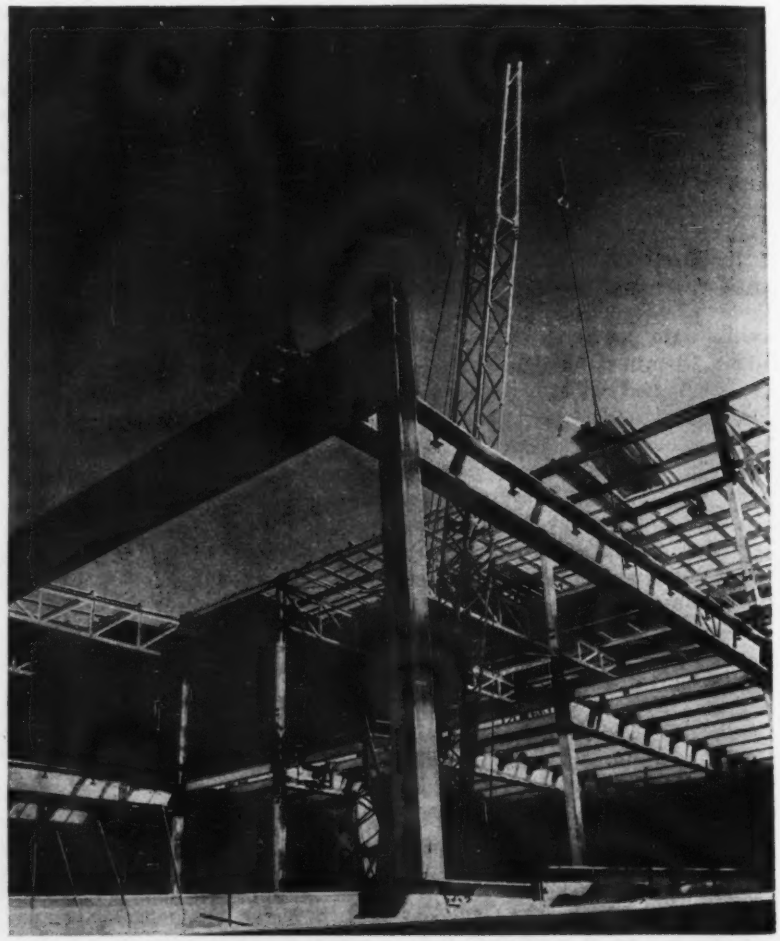
Large I-Beams Welded in Place

WHAT ARE BELIEVED TO BE the largest I-beams electrically welded in place were used in the recently completed addition to the Cleveland, Ohio, works of the Westinghouse Electric & Manufacturing Co. As part of the all-welded 800-ton steel framework for the new structure, twenty 36-in., wide-flange, 300-lb. I-beams, each about 50 ft. long and weighing 8½ tons, were used.

The beams were erected at a height of between 18 and 20 ft. above ground by cranes working at that level. Supported temporarily on brackets and in some instances by bolted connections, the beams were welded in place by one welder working at each end. Cost of the welding was approximately 4c. per lin. ft. including cost of labor and materials. Four 300-amp. welders were used on the project with one or two men to a machine.

The Austin Co., Cleveland, Ohio, held the general contract. T. Hugh Green was construction superintendent.

Over-all dimensions of the manufacturing addition, which is irregular in shape and has been built around an existing plating shop, are 227 by 308 ft. Four production aisles ranging between 50 and 60 ft. in width are provided on each floor, two on either side of a 30-ft. monitor aisle. Columns are spaced 18 ft. 9 in. apart along these aisles designed for fixed conveyor and monorail facilities.



Crane working at ground level erects 50-ft. length of 36-in., 300-lb. I-beam which is to be electrically welded in place. Already welded in place is the 36-in. member upon which the man is standing

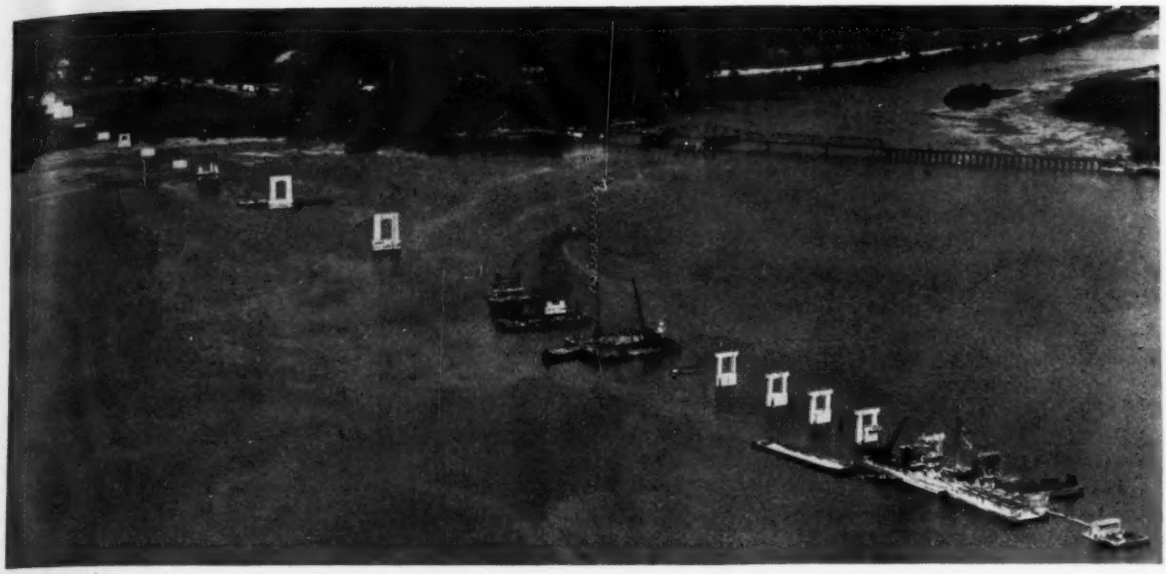


Fig. 1. For the 4,745-ft. bridge over the Illinois River at Peoria, 28 piers are required, all but five being in the river.

Underground Water Supply Complicates Bridge Pier Construction

W. H. Townsend
Construction Engineer, Illinois Division of Highways
Peoria, Ill.

***Contents in Brief**—Foundation piles for the highway bridge now being built to span the Illinois River at Peoria penetrate the water-bearing stratum from which water for Peoria is obtained. Described are the special precautions taken during pier construction to prevent pollution of this supply, and the procedure followed when an unstable gravel complicated the foundation work at the west abutment and three piers. Also outlined is the precise triangulation work required for the location of the 23 river piers.*

IN CONSTRUCTING THE PIERS for a new 4,745-ft. long highway bridge to provide a 26-ft. wide roadway and two 2½-ft. wide safety walks over the Illinois River at Peoria, Ill., unusual conditions were encountered, presenting problems of considerable magnitude, both in design and construction. The Peoria Water Works Co., a private utility supplying water for Peoria, obtains its supply from wells extending into a sand and gravel stratum carrying an underground flow. This stratum is separated from the river flow and groundwater by layers of clay and shale of varying thickness, tests indicating that a 20-ft. head of water was required to penetrate this seal. However, some of the steel H-section bearing piles, planned as foundation support for the bridge, which calls for a 3-span, continuous, through, truss unit over the main channel, were expected to extend into the water-bearing gravel (Fig. 3). Thus, pollution of the company's supply would result unless special precautions were taken. This fact was established, during design of the substructure, by test holes at the approximate locations of the 23 river piers.

As expected, water company officials objected strenuously to river work in any way contaminating the supply, and representatives of the state geologist's office, the Illinois department of public health, the highway department, and the water company held several conferences to discuss the many phases of the problem. The first step, it was generally agreed, was to define the area drained by one of the company's wells.

To do this, a number of test wells were extended into the water-bearing gravel and observations were made hourly for seven days, then daily for two months, and then less often for several more months. By means of floats in these wells the water level could be noted at a glance while pumping was in progress at a company well. These studies indicated that the piling for four piers would extend into the stratum drained by the company's wells.

Protection of the supply during construction was next considered.

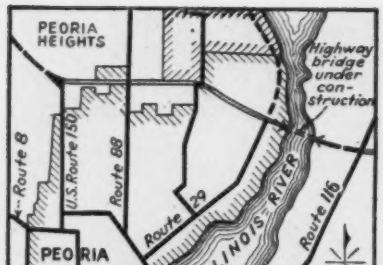


Fig. 2. Located at Harvard St. in northern Peoria, the crossing will disperse traffic over main arteries to the business district, as well as residential areas.

That the method should prevent leakage into the supply was apparent. As a first step, test wells were drilled outside the locations for the four piers involved. These were to determine the groundwater elevation and observe its action as construction progressed.

After the deep-web cofferdam sheet piling, which weighed 42.7 lb. per sq. ft. had been driven the contractor installed pumping equipment to keep water in the inclosed areas at river-bed elevation. Some leakage through the cofferdams occurred, but dumping cinders outside the cofferdams at the points where leakage was taking place greatly reduced the inflow. The pumping, which was to relieve the water head and prevent infiltration into the underground stream before the concrete seals could be constructed, was maintained throughout the excavation and pile-driving operations. This period was from two to three weeks at each pier. Three centrifugal pumps—a 4-in., a 6-in. and an 8-in.—were used to unwater each cofferdam, but after the water was down a 6-in. pump kept each cofferdam dry. With the foundation piles in place and the thick concrete seals poured and cured, the cofferdams were allowed to fill, as the seals removed the pollution danger.

The first cofferdams were designed to extend a minimum of 10 ft. below the seals but, from the test borings, it was impossible to determine with any degree of accuracy the stability of the river-bed material overlying the clay. This necessitated new cofferdam calculations with no resistance allowed for friction between this unstable material and the cofferdam sheeting. To overcome cofferdam buoyancy the thickness of the seal slabs was increased as much as 4 ft. for some piers. A maximum seal thickness of 14 ft. for the tallest piers resulted, which in turn required the contractor to change the cofferdam bracing. The bracing finally decided upon at the four large piers was small steel trusses at the upper levels and heavy steel I-beams lower down. Once the seal slab was in place the trusses could be removed and reused, as could all the I-beam struts above stream-bed level. With the piers in place, the steel sheet piling could also be removed without danger of pollution, since the sheet piling did not penetrate into the water-bearing strata.

The design contemplated construction of the west abutment and nearby Piers 3, 4 and 5 without bearing piles on dry foundations where borings had indicated a thick gravel stratum near the surface. Furthermore, when excavation for these piers was completed, clean coarse gravel was present and although apparently short in fines, appeared to be entirely satisfactory as a foundation material. Construction of the footings was undertaken according to plan, but after the concrete for the second footing had been in place about six hours, there appeared a 20-ft. long crack extending from the footing's edge to almost the center. In addition a segment of the footing settled almost 2 in.

After careful examinations, it was apparent that the crack had formed at a location where the curing water, as it drained off the concrete surface, had concentrated under the footing. Experiments and loading tests definitely indicated that the gravel was not stable when flooded and that shrinkage had apparently occurred, leaving a portion of the footing partly unsupported. The supposition is that the rise and fall of the underground water over many years removed the fines and greatly reduced the gravel's bonding qualities.

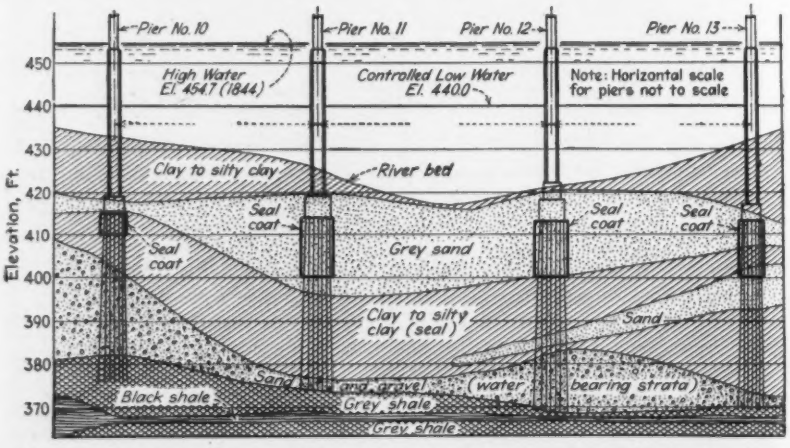


Fig. 3. Foundation piles for Piers 10, 11, 12 and 13 penetrate the stratum from which water is obtained for Peoria and neighboring communities. The vertical scale is ten times the horizontal.

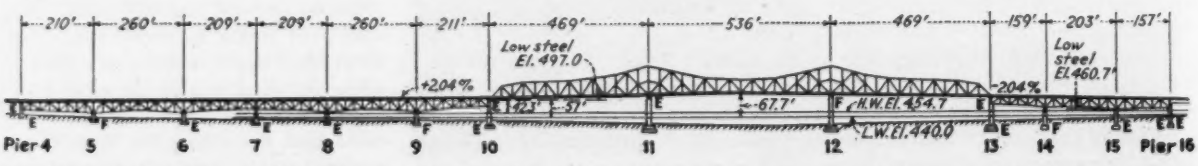


Fig. 4. Central portion of the bridge is of truss construction and includes a 3-span continuous unit providing a 66-ft. clearance over the main channel. In addition to work shown at the left end, two 3-span continuous steel girder units will be required, while at the right end three 3-span continuous girder units, and two 2-span continuous girder units are called for.

Since construction on such foundation material was definitely not advisable, a change in design was made using steel H-section bearing piles for the abutment and all piers originally designed without such support. The two footings already in place were removed and rebuilt with foundation piling used. Although to obtain a maximum pile penetration of 90 ft. was possible, it was necessary to depend, to a great extent, on skin friction on the piling for pier support. The gravel at the west abutment and at Piers 3, 4 and 5 proved to be over 90 ft. deep, since the points of the longest piles were still in that material.

Locating the piers

Because 23 of the 28 piers required were located in the river, which is about 4,000 ft. wide at controlled pool stage, locating and staking out those structures created no small problem. This was solved by an elaborate triangulation system involving six triangles with their legs to the piers, varying from 1,000 to 3,000 ft. Three of these triangles, with their bases along the center line of the bridge and their apexes at three main control points, were generally used. Permanent concrete monuments were erected at several control points and, to protect the precise transit used, houses were erected over the points employed most often.

This entire triangulation system was set up prior to any construction and considerable time was required in checking the many angles involved. To eliminate poor visibility due to light refraction, haze and smoke, a great deal of the instrument work was done at night. An illuminated telescopic transit graduated to ten seconds was used, and the angles were turned to read in series of 10 to 20 times with independent checks of the results in the same manner.

When this system was satisfactorily completed, the actual location of a pier could be quickly given when requested by the contractor. For this work two instruments were used, one at the control point from which the angle to the pier was measured and the other at a shore control point on the bridge's center line. Intersection of the lines of sight located the pier.

At the point thus established the contractor drove a cluster of temporary wood piling on which a platform was constructed. From this the contractor was supplied measurements for locating the cofferdam. With the cofferdams in place, accurate points were established for the footings and then the operations repeated for the pier stems. These several operations proved excellent for the location work.

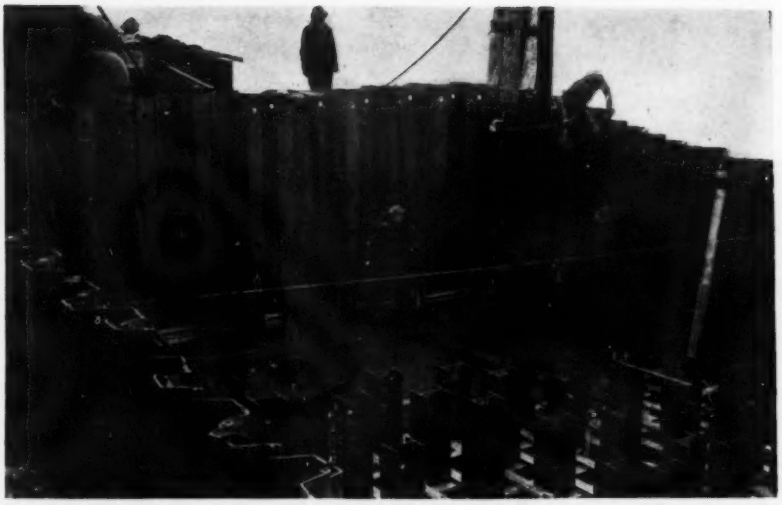


Fig. 5. Pile driving operations, underway for Pier 12, which will have a spread footing. Piles at left have been driven to bearing.

Tall river piers

The two piers to support the main cantilever span are practically identical and the height from the bottom of the seal to the bridge seat is 101 ft., which makes the seat 61 ft. above pool stage. Materials required for a single pier include: 148 12-in., 53-lb. H-section piles, totaling 7,400 lin.ft. in all; 2,600 cu.yd. of concrete; 63,000 lb. of reinforcing bars; 65 carloads of gravel; and 35 carloads of sand. To provide ice protection the two piers are encased with $\frac{3}{8}$-in. thick steel plates, 12 ft. high, as are the two neighboring piers. The bottoms of these plates, are 2 ft. below pool stage.

Equipment and materials for the river piers were delivered by barge. Sand and gravel arrived in separate barges and the bag cement in inclosed scows. Two cranes unloaded the materials and charged the material hoppers on the mixer barge. For the work below water the six-bag mixer charged a bucket elevated by a tower and the concrete was delivered to its final location through chutes and tremies. For the pier work above water the concrete was deposited directly into the forms by buckets handled by a crane on the falsework.

Two pourings of about fifteen hours each were required for the thicker seal slabs. Once the seals were cured, one pouring was required for the footing, two operations to finish the pier's solid part, one pouring for the pilaster portions, and then one pouring for the beam or top portion. Thus, for the larger piers seven separate operations were required, forms being erected for each unit after the preceding pour. About eight to twelve hours of continuous work was required for each of the five last-mentioned operations. Work was carried on 24 hours per day, and concreting was started at any hour during the night and extended continuously until the required placement was finished.

The $2,000,000 project, financed by Illinois and federal funds, is under the jurisdiction of the Division of Highways, Illinois Department of Public Works and Buildings. Designs were executed by George F. Burch, bridge engineer, and construction is supervised by C. M. Hathaway, engineer of construction in the highways division; Theodore Plack, district engineer; the writer, district construction engineer; and V. O. Hart, resident engineer. Great Lakes Dredge & Dock Co., Chicago, L. Filitan, superintendent, and R. N. Trotter, civil engineer, is the substructure contractor. American Bridge Co., Chicago, is fabricating the superstructure steel, and Strobel Construction Co., Chicago, holds the contract for the superstructure erection.

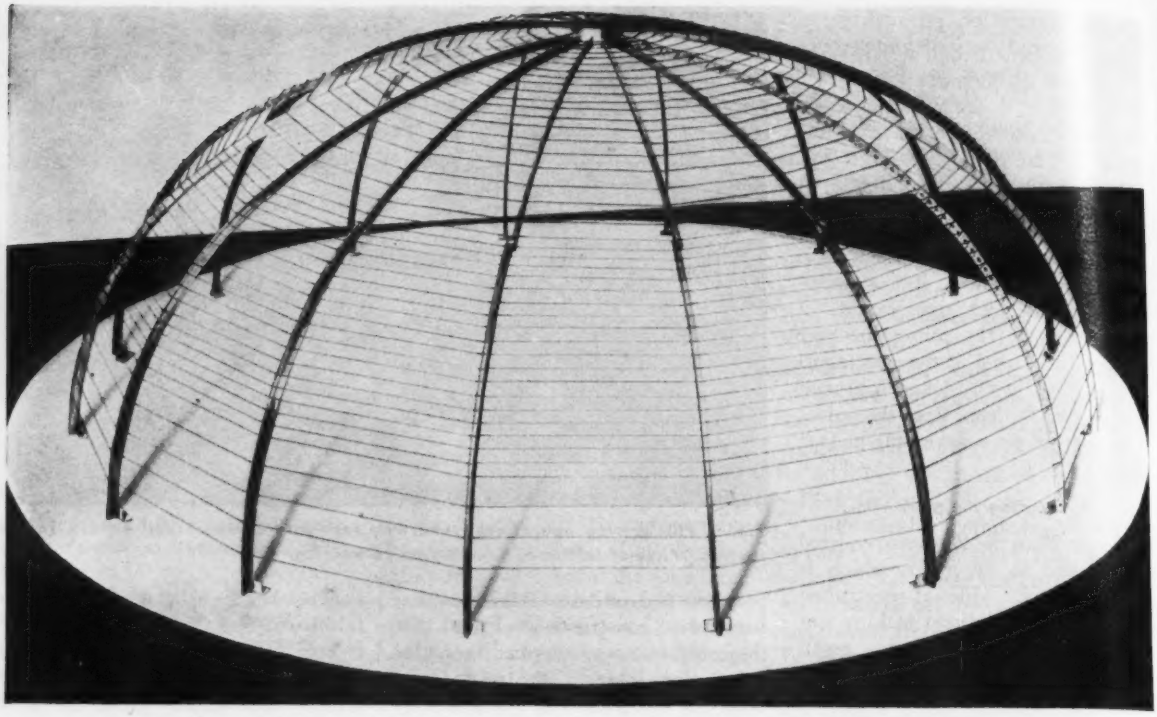


Fig. 1. Model of the "Corbetta Beehive Type" underground storage magazine.

Concrete Beehive for Munitions Storage

Francis R. MacLeay
Chief Engineer, Corbetta Construction Co.
New York, N. Y.

***Contents in Brief**—A new type of underground munitions storage magazine has been devised by Corbetta Construction Co. of New York City, and turned over to the federal government for use without restriction. It is a 6-in thick eliptical beehive dome of concrete and will provide the same volume of storage as the "igloo" type magazine now being built. A comparison of the older design with the new dome indicates a probable saving of 3,000 tons of steel, 130,000 lb. of copper and 50,000 cu.yd. of concrete in an average-size munitions depot.*

An Elliptical Concrete Dome, with bar-truss framing and circumferential tension members of wire welded to the frame, is to be built in quantity for the storage of munitions. The dome is a shape that keeps all the concrete always in compression, and hence requires a minimum thickness and only a small amount of steel reinforcement. The bar-truss framing, shown in Fig. 1, is required to act only as an erection aid and to space horizontal tension wires which completely circle the structure and comprise the principal reinforcement.

Munitions are now generally stored in a so-called "underground magazine" that is actually built with its floor at or near the ground level and is then covered with a minimum of 2 ft. of earth. The structures depend on dispersion for protection, usually being spaced more than 400 ft. apart each way. They are not built to resist a direct bomb hit or to confine an internal explosion.

Several thousand storage units have been built recently. They are known as the "igloo" type, but are actually half of a 26-ft. dia. cylinder and either 60 or 80 ft. long. The elliptical dome type structure, Fig. 2, will be built as a polygon rather than a half spheroid to simplify construction. It will have 16 sides and a nominal "diameter" of 44 ft. 7 in. to give the equivalent storage capacity of the 60-ft. long igloo and 52 ft. dia. for the equivalent of the 80-ft. igloo. The dome type will be covered with earth and separated for protection as the others have been.

One of the structures has been built and tested to assure the practicability of the plan. The dome successfully withstood a 10-ton bulldozer operated over its top and an eccentric loading test of double the usual fill on one side of the structure with the other side unloaded.

The new type storage, to be known as "Underground Storage Magazine, Corbetta Beehive Type," was de-

veloped by the Corbetta Construction Co. of New York City. It has been tentatively accepted by the Ordnance Department and the Corps of Engineers of the U. S. Army as an alternate to the "igloo" type. As a contribution to the national war effort the design has been turned over to the federal government for use without restriction.

The dome was designed for a live load of one hundred pounds per square foot in addition to the weight of the earth over the structure and forces set-up by the earth around the circumference. The 6-in. concrete shell is necessary to enclose the bar-truss which is 4 in. in depth. This thickness of wall reduces the unit compression stresses in the concrete to a very small figure, indicating that the dome could be safely designed with a much thinner concrete shell. However, studies along this line convinced the author that it was neither practical nor economical to reduce the thickness below 6 in., as the cost of forms would be magnified. The increased care necessary would introduce a time element which might reduce the speed of erection so essential to the government program.

There are three principal advantages of the "beehive" storage structure:

(1) For the same volume of storage, less than half the steel, about one-third of the copper and two-thirds of the concrete will be required (see the accompanying table).

(2) Man-hours of labor and the time for construction will be substantially reduced.

COMPARISON OF QUANTITIES IN THE "BEEHIVE" AND "IGLOO" UNDERGROUND STORAGE MAGAZINES

	50-ft. igloo	44-ft. 7 in. beehive	Saving in beehive
Concrete volume	160 cu. yd.	99 cu. yd.	61 cu. yd.
Reinforcing steel	7,641 lb.	516 lb.	
Reinforcing mesh	4,323 lb.	1,300 lb.	
Bar-trusses		1,655 lb.	
Wire bands		967 lb.	
Total steel	11,964 lb.	4,438 lb.	7,526 lb. (3.76 tons)
Copper	240 lb.	90 lb.	
Man hours (estimated)	1,500	900	600
	80-ft. igloo	52 ft. dia. beehive	saving in beehive
Concrete volume	194 cu. yd.	127 cu. yd.	67 cu. yd.
Reinforcing steel	9,366 lb.	809 lb.	
Reinforcing mesh	4,741 lb.	1,717 lb.	
Bar-trusses		2,319 lb.	
Wire bands		2,054 lb.	
Total steel	14,107 lb.	6,897 lb.	7,210 lb. (3.6 ton)
Copper	260 lb.	90 lb.	170 lb.

(3) Ventilation characteristics of the dome, with air rising to a top ventilator, without pockets where condensation may occur, are said to be of definite aid in "keeping the powder dry."

The beehive has the ventilator at the top and center of the dome and it is believed will give better ventilation characteristics than the long igloo as there is little possibility of "dead-air" pockets where the air stagnates and moisture condenses.

The beehives are protected from grass fires by means of fusible links on the ventilator and grill dampers. Lightning protection consists of a copper lightning rod attached to the ventilator and brazed to the steel plate ventilator collar. The structures are protected from static electricity by the welding of all metal parts to the bar-trusses, and they, in turn, are grounded.

When the savings shown in the

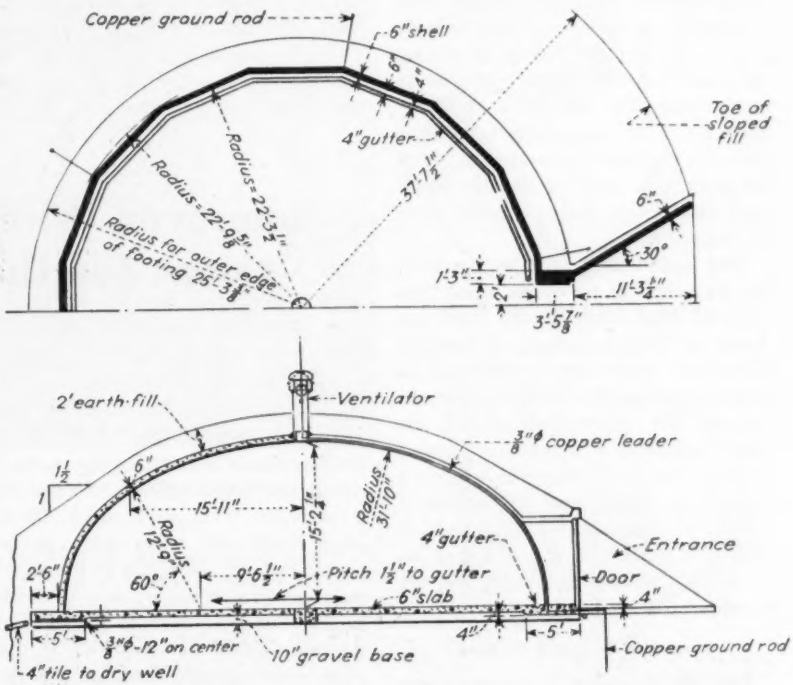


Fig. 2. The beehive dome will be a polygon shape, rather than a true spheroid, to simplify construction.

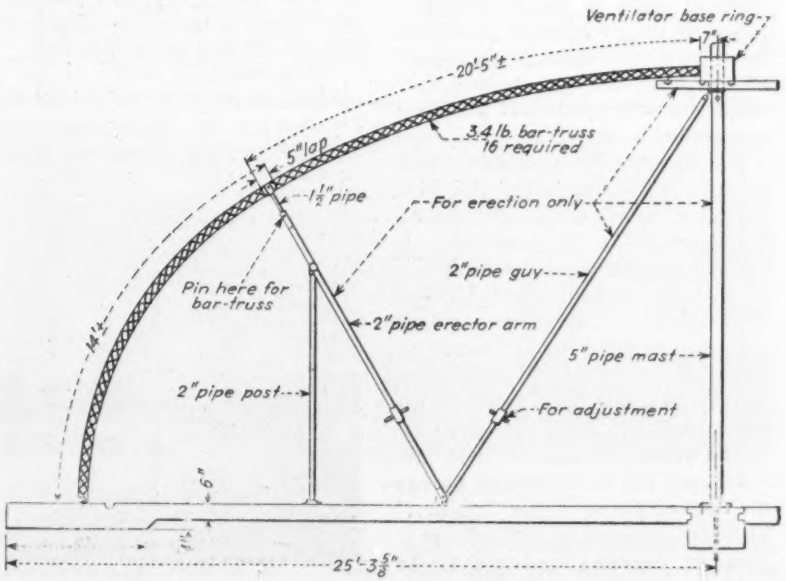


Fig. 3. Construction centers around the bar-truss and the temporary center mast. All pieces are designed for manual handling.

table are multiplied by the 800 such structures in the usual munitions depot, it indicates a possible saving of 3,000 tons of steel, 50,000 cu.yd. of concrete and 130,000 lb. of copper. When this is again multiplied by the several depots and scattered groups of smaller numbers of storage structures near manufacturing plants and shipping points, it amounts to large quantities of scarce materials saved. While concrete materials are generally available, construction equipment is becoming increasingly hard to get, and the savings in mixing and handling the concrete as well as transporting the 100,000 tons of aggregates is an important consideration. An estimated reduction of about 20 percent in cost for the "beehive" type would be a major consideration in normal times.

The foundation for the structure can be simple as no stress, other than vertical dead load, comes from the dome. A 2,000-lb. per sq. ft. bearing value soil, which can be obtained on well-compacted fill, is satisfactory to support the expected loads of the filled building. A 6 to 10-in. gravel base to provide drainage is laid on a leveled area and over this is placed a 6-in. mech-reinforced concrete slab with the outside 5 ft. thickened to 10 in. to provide a footing for the concentrated load.

Dome not fastened to base

The elliptical-shaped dome is not connected in any way to the base mat. This detail is considered an essential point in the design as it precludes the introduction of stresses into the dome caused by settlement of the mat, and permits free contraction and expansion of the dome proper under stress.

Not fastening the dome to the base permits it to rise from the base quickly, releasing the increasing pressures caused by any internal explosion and thus reducing the magnitude of the blast. An additional advantage is the ability of the dome to shift sideways on the base, in case of an explosion in a nearby magazine, thereby minimizing damage to the dome itself.

The framing members used are 3.4-lb. per lin. ft. bar-trusses bent to the desired curve of the "beehive." They are designed in two sections to facilitate handling and are to be welded at their junction. The rolled bar-truss sections of light material are available for this work, with the proper priority rating, but the mills contacted are unable to roll them to the radius required due to slowing of the rolls for this added service. Corbetta has developed a workable scheme for bending the trusses cold.

The circumferential stresses in the structure are taken by $\frac{3}{8}$ in. and $\frac{1}{4}$-in. dia. wire "wrapped" around the structure as shown in Fig. 1. The large wire is used near the bottom of the structure and the smaller diameter where stresses are small near the top.

Entrance to the "beehive" is through a short tunnel section that has a steel door of the same design as the igloo storage. Flared wingwalls hold back the earth cover to increase the size of the working platform where trucks will be unloaded and loaded in moving materials in and out.

Waterproofing of the structure will be done with 4 ply-built-up roofing material or perhaps only by spraying with asphalt if tests prove this method satisfactory.

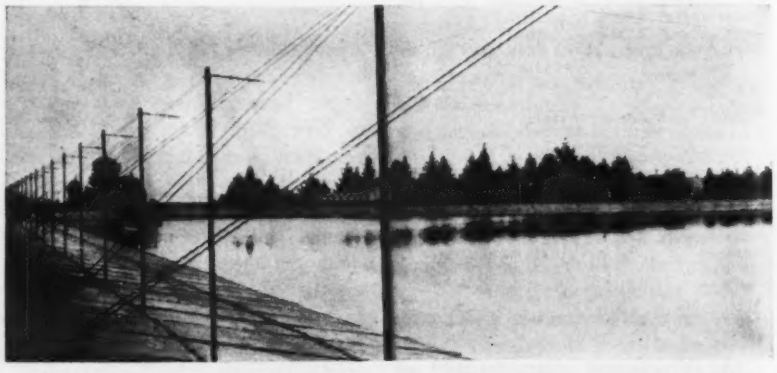
The beehive type of underground storage magazine was originated and patented by Louis P. Corbetta. The idea was developed and the structure designed by the author who is chief engineer, Corbetta Construction Co.

Improved Wire Suspension Plan Keeps Sea Gulls off Reservoir

WIRES HAVE BEEN STRUNG over reservoirs in coastal cities for many years to prevent sea gulls from landing on the water surface. The East Bay Municipal Utility District at Oakland, Calif., uses a wire-stringing method which makes this scheme effective on a reservoir 700 ft. wide and 1,500 ft. long. Since the wires have to be stretched both ways, the longitudinal runs on this reservoir are of such length that considerable mechanical strength would be required if the wires were unsupported for the entire span. However, the transverse wires were placed first and the longer spans are put on top, thus providing intermediate supports that greatly reduce the stresses in the long runs.

Galvanized wire of No. 6 size is used for the transverse runs and No. 11 wire for the longitudinal runs. In order to keep wires clear of the water surface at mid-span, $2\frac{1}{2}$-in. pipe supports (from 6 to 16 ft. high) were set up just above high-water line along sides and ends of the reservoir. Each of these supports is tied back with two pairs of guy wires to oppose the pull of the catenary. The wire spacing in both directions is 30 ft. A turnbuckle is used in one end of each span to adjust the sag uniformly.

Even though galvanized wires are used, nearness to the coast and the frequency of salt fog causes corrosion to such an extent that it has been found desirable to keep the wires coated with heavy grease. The grease is applied, usually about once a year, with the aid of a scow kept on the reservoir for the purpose and equipped with a trestle so that workmen can reach the wire near the shore as well as at the low points.



Wires 30 ft. apart in both directions, with spans ranging up to 1,500 ft., keep sea gulls off the water surface of this reservoir.

From Field and Office

Working problems and time-saving methods for engineers and contractors

Works Progress Administration Photo

JACOB'S LADDER PROVES VALUABLE FOR BRIDGE PAINTERS

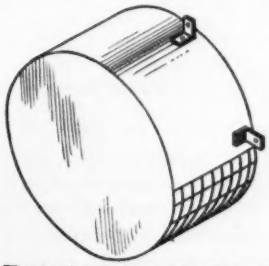
Designed and built by a WPA foreman who served 14 years in the U. S. Navy, the inexpensive painter's scaffolding shown above is proving very effective in painting bridges in Wapello County, Iowa. The rig, which uses Jacob's ladders to support the scaffolding plank, is so simple that it may be erected in half an hour. In addition there is no interference with highway traffic.

Specially designed steel hooks—adjustable for use on bridge girders of different sizes—were added to the usual seaman's ladder, which has two ropes knotted at regular intervals to hold the cross-steps in place. When the hooks are locked across the top of the bridge structure, the ladders hang about 18 in. from the bridge trusses, leaving plenty of space through which cars and trucks may pass.

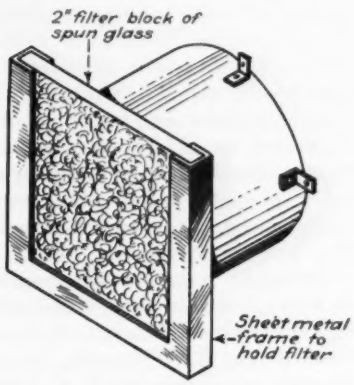
Rungs of the ladders are curved slightly upward and strengthened by a cable running underneath. The cables have turnbuckles for taking up any slack that may occur and for maintaining the step's upward curve. The planks used for the scaffolding are of spruce, 2 in. thick and 12 in. wide. They are also reinforced by steel cables with turnbuckles and are tied to the bridge girders when in use. Two or three planks may be used at a time in painting the structure if the bridge is of sufficient height. Likewise, at the same time other planks may be used transverse to the line of traffic or parallel to the horizontal bridge members. This permits the painting of an entire bridge section before moving the scaffold.

Air Filters on Welding Machines Reduce Maintenance Costs

At a large defense plant in the Middle West a fleet of portable welding machines has been equipped with spun-glass air filters to save maintenance. The usual lattice cap, through which cooling air is drawn, is replaced with a sheet-metal frame holding a 2-in. block of spun-glass air filters. The company reports that

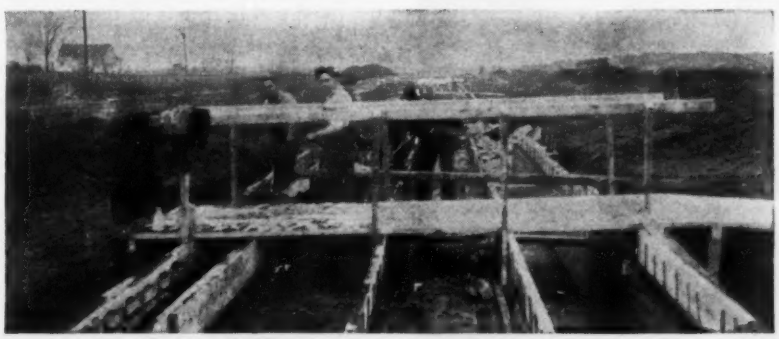


Typical Welding Machine Cap



Cap Replaced with Air Filter

Method of adding spun-glass air filters to reduce maintenance with portable welding machines.



FOOTBRIDGES PROVIDE SAFETY

To keep workmen from being injured, once snow arrives, by stumbling over completed foundations for the buildings at a large bomber repair depot, the U. S. Engineers are having small footbridges built where workmen normally cross the foundations. Note also how precautions are taken to prevent the steel dowels from being knocked out of line.

where it was formerly necessary to stop the machines about every week and blow out the accumulated dust, the welders now run for three or more months between dust removals. The filters are changed and cleaned every two or three weeks, the change being made without shutting down the machines. Increased efficiency from the dust-free welding machines is also reported.

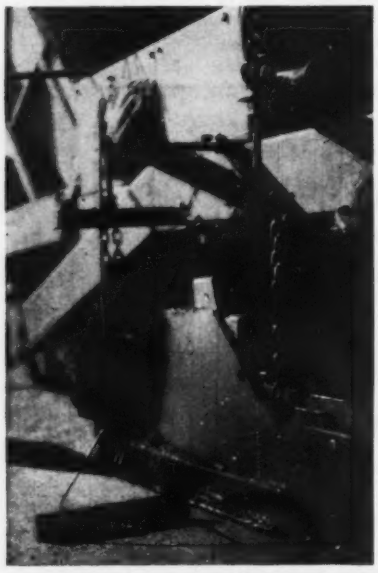
Excluding cost of the homemade frames, the filter units cost about $1 each, while cleaning costs are 50c. per change.

Aids Paver to Follow Grade

Termed a "tickler" for want of a better name, a rod supporting a short length of a steel angle as shown below is being used very effectively by the paving-machine operator in placing asphaltic concrete on an Oregon airport job. The device is set just ahead of the machine's strikeoff bar and enables the operator to follow closely the header grade or the grade on the adjoining pavement.

By a turnbuckle at the upper end of the rod the tickler can easily be set at a distance above the strikeoff bar equal to the compaction factor, which can be calculated very closely after a little experience.

The tickler, which was designed by the writer, has been used successfully on a number of different types of pavers.—JAS. E. O'HEARNE, *senior inspector, airport paving, U. S. Engineers, Portland, Ore.*



"Tickler" to aid paver operator.

Field and Office Comment

Chart for Spacing Stiffeners

Sir: Two typographical errors occurred in my article "Chart for Spacing Stiffeners" (*ENR*, Jan. 29, p. 207). The A.I.S.C. formula, directly above the nomenclature, should read

$$\frac{270{,}000t}{v}\sqrt[3]{\frac{at}{h}}$$

The v under $270{,}000t$ was overlooked in setting the type. Also the maximum shear should read 13,000 psi. instead of 12,000 psi.

M. J. MARCUSON
Structural Engineer
Batavia, N. Y.

Fixed End Moments

Sir: For designers who dislike the use of tables such as that given by Professor Posey for fixed end moments for hydrostatic type loadings on prismatic beams (*ENR*, Nov. 6, 1941, p. 671), the following procedure is suggested. In Fig. 1, if the triangular load $W = \frac{1}{2}aw = 6{,}480$ lb. be concentrated at its center of gravity A, the simple span moment diagram would be triangular (BCD) and the fixed end moments would be:

$$\text{Left} - \frac{W\delta^2 c}{L^2} = 21{,}560 \text{ ft.-lb.}$$

$$\text{Right} - \frac{W\delta c^2}{L^2} = 33{,}880 \text{ ft.-lb.}$$

The shaded part of the diagram shows the difference between the moment areas of the concentrated and the triangular loadings. Obviously the fixed end moments of the concentrated load must be reduced by the effect of this difference, the area of which is

$$\frac{w.a^3}{72} = \frac{W.a^2}{36} = \frac{(6480)(9^2)}{36} = 15{,}390 \text{ ft. sq.-lb.}$$

and the center of gravity $\frac{2}{45}\,a = 0.4$ ft. to the left from A. Its reactions are:

$$\text{Left} - 15{,}390\frac{14.4}{36} = 6{,}156 \text{ ft. sq.-lb.}$$

$$\text{Right} - 15{,}390\frac{21.6}{36} = 9{,}234 \text{ ft. sq.-lb.}$$

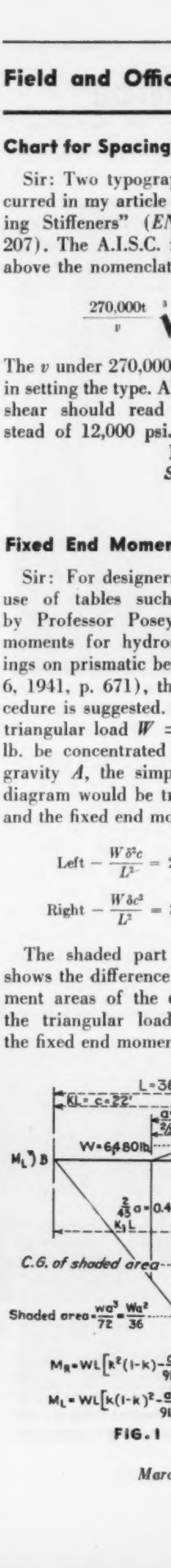


FIG. 1

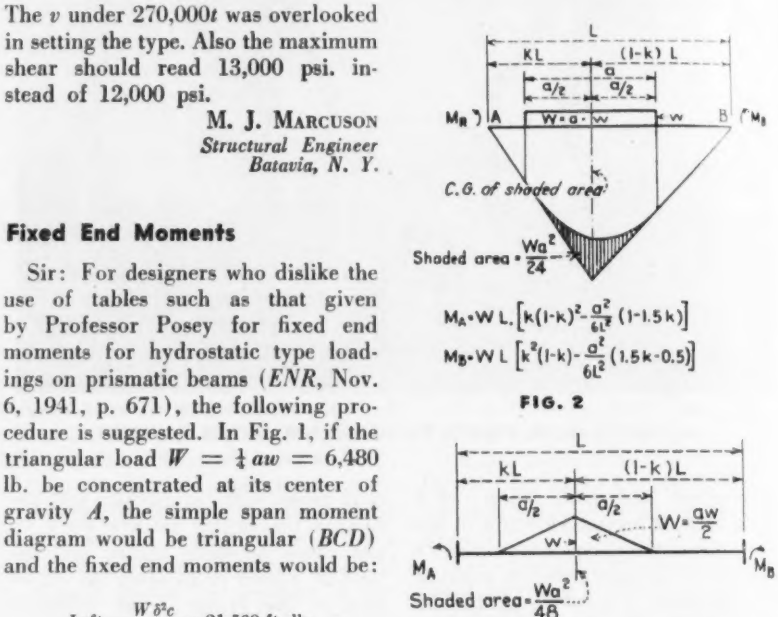


FIG. 2

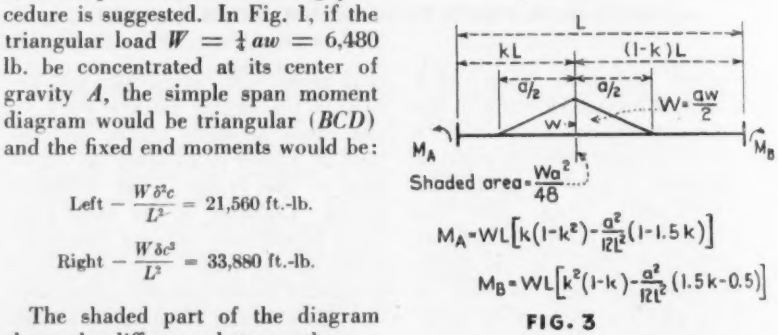


FIG. 3

Fixed end moments caused by these area reactions are:

$$\text{Left} - \frac{4}{36}(6156 - \tfrac{1}{2} \times 9234) = 171 \text{ ft.-lb.}$$

$$\text{Right} - \frac{4}{36}(9234 - \tfrac{1}{2} \times 6156) = 684 \text{ ft.-lb.}$$

The fixed moments of the triangular loading therefore are:

$M_L = 21{,}560 - 171 = 21{,}389$ ft.-lb.

$M_R = 33{,}880 - 684 = 33{,}196$ ft.-lb.

Fig. 2 shows the case of uniform partial loading. Fig. 3 is another case symmetrical about the center of gravity. Properties of the shaded area can be derived by simple integration, using the special case of $a = L$, that is, fully loaded spans.

JOHN VAMOSI
Structural Engineer
Chicago, Ill.

Book Notes and Reviews

The month's addition to the engineer's reading and reference list

Drought Studies

FURTHER CARTOGRAPHIC STUDIES OF DROUGHT—By W. R. Baldwin-Wiseman. Reprinted from the *Quarterly Journal*, Royal Meteorological Society, London, England.

This paper is the latest among a growing number on the classification of climate, the present paper having particular reference to drought. The quantitative definition of drought from climatological data is a most desirable goal but success must be measured in terms of immediate significance to drought effects such as crops, streamflow, and groundwater, and dependent uses of water.

The method outlined in this paper delineates the areas where drought incidents are greatest, but does not describe just how the figures are to be applied to determine the relative stability of crops and of water supplies in the various areas. Mr. Baldwin-Wiseman has defined a drought as "a defect of 50 percent or more from the mean rainfall of three or more consecutive months," and in this respect differs from other published treatments. The method proposes the preparation of charts showing lines of equal aggregate deficiency in rainfall in terms of (1) percent of time, (2) percent of mean rain, and (3) mean rainfall deficiency during drought. The author rightly insists that long records (he has used 50-year stations) are necessary for reliable definition of drought incidents. These charts seem to point out the areas where drought risk is known to be large and confirm a general observation that drought is more frequently recurrent in areas of low rainfall than in humid areas. Mr. Baldwin-Wiseman should have incorporated the chart showing native vegetation or a generalized soils map in order that the reader, unacquainted with the geography of Queensland, could form his own judgment of the significance of the author's climatic charts in relation to conditions in other places. A minor point is that it is not clear why annual cumulations of precipitation were begun in the mid-summer month of January when precipitation was greatest. The suggestion is that a climatic year beginning in October would be more practical. A second point is that the method ignores the departures of temperature from normal that would affect the efficiency of the precipitation.—*Reviewed by* W. B. LANGBEIN, *associate hydraulic engineer, U. S. Geological Survey, Washington, D. C.*

Photoelasticity

PHOTOELASTICITY: VOL. I — By M. M. Frocht. 441 pp. John Wiley & Sons, New York; Chapman & Hall, London. $6.

The new volume on photoelasticity by Max Frocht is a most welcome addition to the literature dealing with this type of stress analysis. The author, an outstanding investigator in the field, has brought together in a single book the results of many developments in laboratory technique and contributions to the scientific journals.

The book deals with the purely optical methods of the photoelastic analysis, the laboratory technique involved, the various methods of interpreting the observations and computing the stresses. Other auxiliary methods are to be taken up in a second volume.

Although a number of advanced problems embodying the theory of elasticity in their solution have been considered, the author has been particularly careful to make his book useful for beginners and in classroom instruction by building up his theory from the beginning. To this end he has included a very complete discussion of stress and strain relations in two dimensions and a large number of illustrative numerical examples to show the detail of solution for the various methods which he employs. An elementary knowledge of applied mechanics and optics are the only prerequisites for an understanding of the text which is written in a logical and easily understood manner.

The book is written from the point of view of an engineer and as such should appeal to the designer who would like to know and use the power of photoelasticity for solving certain difficult problems by a quick simple process. Both the author and the publishers are to be congratulated on the many beautiful illustrations and splendid presentation of a fine text and reference book.—*Reviewed by* W. M. MURRAY, *assistant professor of mechanical engineering, Massachusetts Institute of Technology, and chairman of the executive committee, Eastern Photoelasticity Conference.*

New Surveying Texts

ENGINEERING SURVEYS: ELEMENTARY AND APPLIED—By H. Rubey, G. E. Lommel and M. W. Todd. Text, 664 pp.; tables, 146 pp. The Macmillan Co., New York. $4.50.

SURVEYING—By Charles B. Breed. Text, 400 pp.; tables, 95 pp. John Wiley & Sons, New York; Chapman & Hall, London. $3.

ELEMENTARY PLANE SURVEYING—Second Edition. By Raymond E. Davis. Text, 334 pp.; tables, 113 pp. McGraw-Hill Book Co., New York and London. $3.

Three earlier texts by one or more of the three authors of "Engineering Surveys" have been combined in the new text in order to provide in a single volume information for a complete course in surveying. The elementary surveying information is identical with that in the earlier book "Engineering Surveys: Elementary" which still is to be separately published. Sections on applied surveying have been largely rewritten and amplified to bring them up to date on recent developments in such fields as photogrammetry. No attempt has been made, however, to cover fully the latter subject or the specialized field of the U. S. Coast and Geodetic Survey. Tables have been amplified.

Prof. Breed's new textbook is designed to meet a need created by the abridgement of surveying courses in many engineering schools. It provides the fundamentals, with special emphasis on surveying instruments and their use in the field. To this end, many field problems have been included. Material given in the chapter on lines and grades is designed to be most useful to young engineers whose first work will be on construction operations.

The second edition of Prof. Davis' book "Elementary Plane Surveying" has been rewritten and new material on surveying instruments, on measurement of areas, on operations connected with construction, and on pho-

togrammetric surveying has been added.

All three texts are in the so-called pocket size, but the first one requires a large pocket.

Miscellaneous Notes on Booklets and Reprints

LOCAL PLANNING ACTIVITY in the United States is the title of the latest bulletin issued by the Bureau of Urban Research, Princeton University. Princeton, N. J. Copies are 25c.

MUNICIPAL LAW PROBLEMS raised by the war are discussed in Appendix 2 of "Chicago's Law Year—1941." Copies can be obtained from the Department of Law, 511 City Hall, Chicago, Ill.

"MAKING ROPE LAST LONGER" is the title of a small pamphlet put out by the Plymouth Cordage Co., North Plymouth, Mass., as a contribution to the nation's war effort. The pamphlet outlines briefly the proper care of rope to extend its life.

TABLES OF NATURAL SINES AND COSINES and of Natural Sines and Radians, prepared originally by R. A. Davis, have been issued in bulletin form (MM 192 and MM 193) by the Marchant Calculating Machine Co., Oakland, Calif., with instructions as to how to use the tables in calculating machine operations.

"PRODUCING FOR WAR," a pamphlet just issued by the Research Institute of America, 292 Madison Ave., New York, covers such subjects as Army and Navy buying practices, how to get war contracts and subcontracts, financing war work, operating under a government contract, handling inspection, taxes on government contracts. Price, $2.

DIMENSIONS AND WEIGHTS of vitrified clay sewer pipe and miscellaneous vitrified clay products are given in a new handbook of the Clay Sewer Pipe Association, 947 Oliver Building, Pittsburgh, Pa. Included is a dimension schedule for extra-strength sewer pipe made to specifications adopted by the American Association of State Highway Officials and the American Railway Engineering Association, which specifications are now being considered by the federal government's Committee on Specifications for inclusion in current federal specifications.

A REVISED "MANUAL OF STANDARD PRACTICE" has been issued by the Concrete Reinforcing Steel Institute, Builders Building, Chicago. Revisions bring the manual into harmony with the latest A.C.I. building-code regulations for reinforced concrete, the new Reinforced Concrete Design Handbook, and the report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete. Copies will be supplied to engineers and architects without charge.

THE GREAT NEW ENGLAND FLOODS of 1936 and 1938 have been the subject of intensive study by the committee on floods of the Boston Society of Civil Engineers since soon after the 1936 flood. Results of this study have now been published as Section 2 of the *Journal* of the society for January, 1942. The committee presents the hydrologic data essential to an understanding of the significance of the 1936 and 1938 floods and discusses the findings of the flood committee appointed after the 1927 flood in the light of the new knowledge gained in the more recent floods, especially that of 1938. This discussion includes a consideration of the so-called "B.F.C.E. flood formula." Copies may be obtained from Everett N. Hutchins, 715 Tremont Temple, Boston. Price, $1.

METHODS USED in the measurement and analysis of sediment loads in streams, under study for some years past at the Iowa Institute of Hydraulic Research, are covered in five reports just issued by the cooperating agencies, the Tennessee Valley Authority, Corps of Engineers, Department of Agriculture, Geological Survey, Bureau of Reclamation, Indian Service, and the Iowa Institute of Hydraulic Research. Copies of the report may be examined in the offices of the cooperating agencies, and a limited number of copies, available to those actively engaged in the subject, can be obtained from the District Engineer, U. S. Engineer Office, St. Paul, Minn., at prices indicated in the following: No. 1, Field Practice and Equipment Used in Sampling Suspended Sediment, $1; No. 2, Equipment Used for Sampling Bed-Load and Bed Materials, 50c; No. 3, Analytical Study of Methods of Sampling Suspended Sediment, 50c; No. 4, Methods of Analyzing Sediment Samples, $1; No. 5, Laboratory Investigations of Suspended Sediment Samplers, 50c.

New Engineering Books

INDUSTRIAL WASTE TREATMENT PRACTICE—By E. F. Eldridge. 401 pp. McGraw-Hill Book Co., New York and London. Price $5.

NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS YEAR BOOK—1942. Published by the society at Grand Central Terminal Bldg., New York. 576 pp. Price $10.

ELASTIC ENERGY THEORY—Second Edition. By J. A. Van Den Broek, 298 pp. John Wiley & Sons, New York. Price $4.50.

CONTINUOUS BEAM STRUCTURES—By Eric Shepley. 113 pp. Concrete Publications, 14 Dartmouth St., Westminster, S. W. 1, London. Price 7s. 6d, net. *Obtainable through Engineers Book Shop, 168 E. 46th St., New York.*

PLANNED A. R. P.—By Tecton, Architects. 138 pp. Chemical Publishing Co., Brooklyn, N. Y. Price $2.50. *A British book on air-raid precautions.*

CIVIL DEFENSE—Third Edition. By C. W. Glover. 926 pp. Chemical Publishing Co., Brooklyn, N. Y. Price $16.50. *The principal British book on method for protecting civilians against air raids, reproduced for distribution in this country.*

Reports and Pamphlets

CONTINUOUS HOLLOW GIRDER CONCRETE BRIDGES—Portland Cement Association, 33 West Grand Ave., Chicago, Ill.

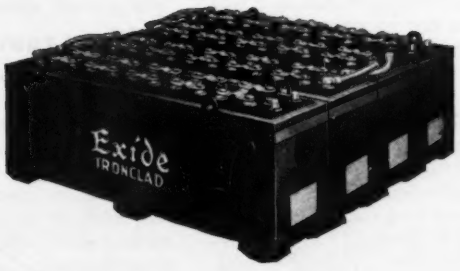
ARCHITECTURAL DESIGN OF CONCRETE BRIDGES—Portland Cement Association, 33 West Grand Ave., Chicago, Ill.

A REPORT ON SUBSIDENCE LITERATURE SURVEY AND THE LAW ON SUBJACENT SUPPORT—By C. B. Wagner. West Virginia University, Morgantown, W. Va. Series 42, No. 1—1.

TESTS OF CYLINDRICAL SHELLS—Bulletin series No. 331, Engineering Experiment Station, University of Illinois, Urbana, Ill. Price $1.

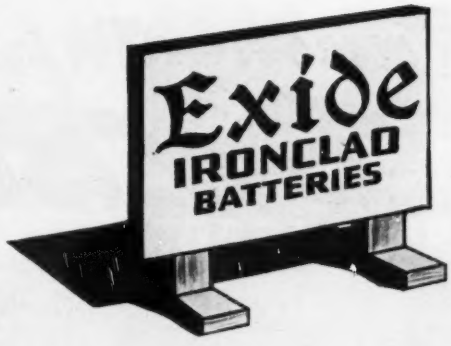
(*Continued on p.* 83)

... and Exide steps up the pace



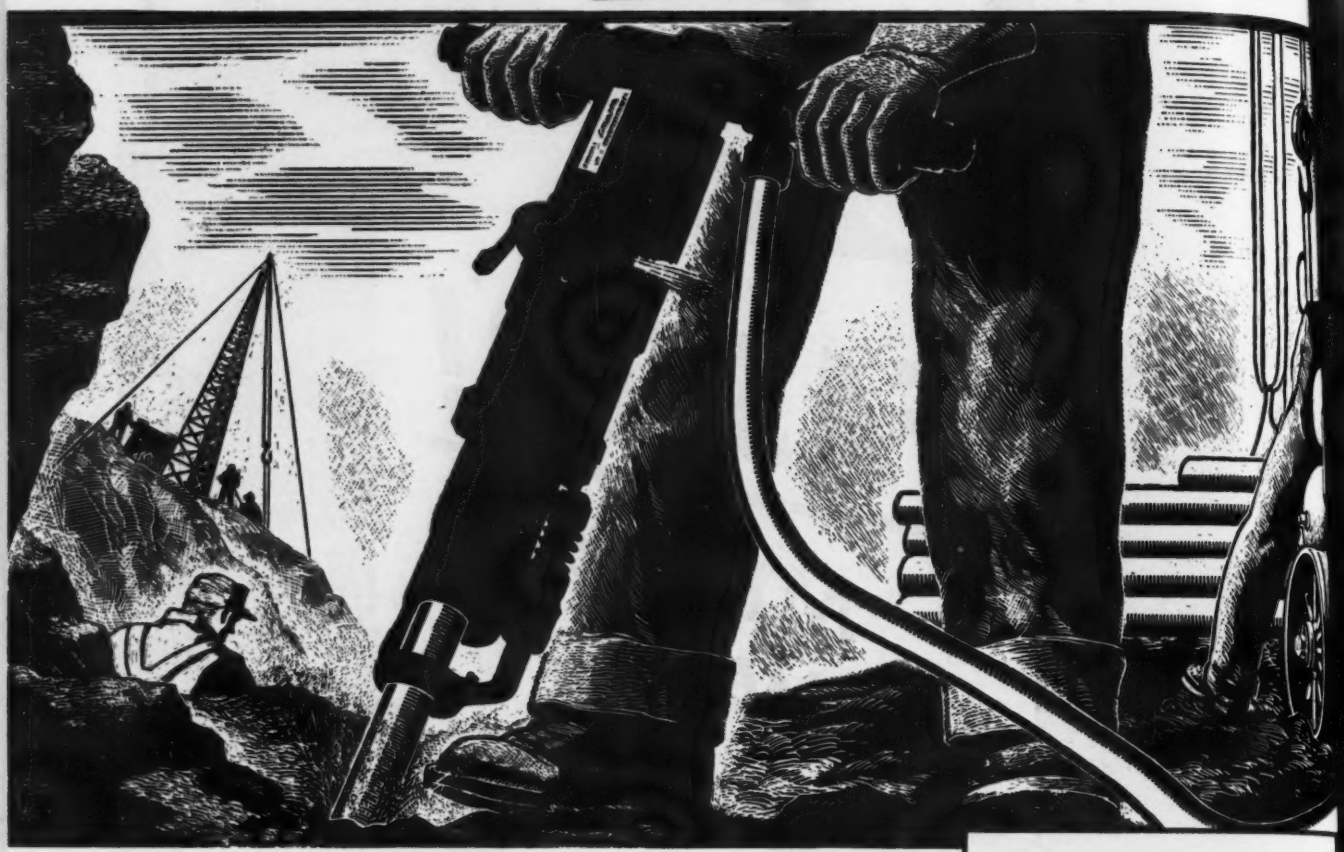
No *safe* degree of speed can be too great when a nation arms for total war. Every mine and open pit must push production at maximum pace.

In mines, quarries and open pits in all parts of America, Exide-Ironclad Batteries power storage battery locomotives, trammers and shuttlecars to speed the flow of vital minerals and ores. Underground, more Exides are used than all other makes of batteries combined. Underground, as everywhere, Exide helps *Keep America Rolling.*



THE ELECTRIC STORAGE BATTERY CO., Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

THIS BRUTE SAVES ITS BREATH.



This two-fisted, rugged rock drill stays on the job longer — with no air-wasting "back-talk."

Worthington's Blue Brute Rock Drill (WJ-55) saves *your* breath, too, for you don't waste hell and damnation on a tool that is easy on the operator and rarely interrupts the work for maintenance and repairs.

All Worthington Blue Brutes are like that. Rock drills and air tools, designed for a complete range of jobs . . . from hardest rock to clay or fitchery earth . . . *use less air,* cause less trouble, save time and money in the long run. Portable and semi-portable compressors . . . gasoline-driven, diesel, electric . . . equipped with Worthington's time-tested "Feather Valves" . . . *deliver more air,* more smoothly, more economically.

Get a demonstration, *now, on your present job,* of how Blue Brutes will help you get more WORTH from air!

FREE EQUIPMENT SAVER

Ask your nearest Worthington distributor, listed on page **83,** for the free EQUIPMENT SAVER which shows you how to conserve scarce metals, lowering maintenance costs for all Blue Brute users from coast to coast. If your distributor is not listed, let us send you this free cost-cutting aid to efficient production direct from Holyoke.

On the Job with

BLUE BRUTES

A Worthington Blue Brute WJ-55 Rock Drill, on trial at a western quarry, made such a hit with the operators that they tried to keep it by *hiding* it when the trial was over! Said the Super, after buying: "It out-drills all our competitive makes by 2 or 3 inches per minute."

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Get more WORTH *from air with* WORTHINGTON

BUY BLUE BRUTES

Compressors from 60 to 500 cu. ft. capacity in mount-

always set the pace for easy operation — available in

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Birmingham — Ed Gantt Machinery Co., Inc.
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Los Angeles — Smith Booth Usher Company
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COLORADO
Boulder — Standard Machine Works
Denver — Morse Bros. Machinery Company
CONNECTICUT
Hartford — Holmes-Talcott Company
GEORGIA
Atlanta — Tractor & Machinery Co., Inc.
IDAHO
Twin Falls — Nelson Equipment Company
ILLINOIS
Chicago — Kennedy-Cochran Company
Chicago — George W. Morrow
Rock Island — Western Equipment & Supply Co.
INDIANA
Indianapolis — Reid-Holcomb Company
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Albany — Larkin Equipment Company
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Olean — Freeborn Equipment Company
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Syracuse — Harrod Equipment Company
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Cincinnati — Finn Equipment Company
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Oklahoma City — Town-Sco Equipment Co.
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Portland — Andrews Equipment Service
PENNSYLVANIA
Easton — Sears & Bowers
Harrisburg — N. A. Coulter
Philadelphia — Metalweld, Inc.
Pittsburgh — John McC. Latimer Company
Wilkes-Barre — Ensminger & Company
SOUTH CAROLINA
Columbia — Bell-Lott Road Machinery Co.
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Chattanooga — James Supply Company
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Dallas — Shaw Equipment Company
Houston — McCall Tractor & Equipment Co.
San Antonio — Patten Machinery Company
UTAH
Salt Lake City — James A. Wade Company
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Richmond — Highway Machinery & Supply Co.
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Get more WORTH from air with WORTHINGTON

Buy Blue Brutes

Worthington Pump and Machinery Corporation, Harrison, N. J. Holyoke Compressor and Air Tool Department, Holyoke, Massachusetts.

Reports and Pamphlets

(*Continued from p. 80*)

ANALYSIS OF SKEW SLABS—Bulletin Series No. 332, Engineering Experiment Station, University of Illinois, Urbana, Ill. Price $1.

BEHIND THE EAGLE STAND THE FORESTS—Timber Engineering Co., Inc., 1337 Connecticut Ave. N. W., Washington, D. C.

REGIONAL PLAN ASSOCIATION — Twelfth Annual Report, December 1941. Regional Plan Association, 400 Madison Ave., New York, N. Y.

PATENT BACKGROUND FOR ENGINEERS—Reprinted from Allis-Chalmers Electrical Review. Allis-Chalmers, Milwaukee, Wis.

A YEARBOOK OF RAILROAD INFORMATION—Committee on Public Relations of the Eastern Railroads, 143 Liberty St., New York.

CONCORD, N. H.—Sixty-ninth annual report of the Board of Water Commissioners, 1940.

NEW JERSEY—Report of the special committee on water supply to Senate and General Assembly. Trenton, N. J.

CAMBRIDGE, MASS.—Annual report of the Board of Health, 1940.

CHICAGO—Sixty-fifth annual report of the Department of Public Works and annual report of the Department of Streets and Electricity, 1940.

NEW JERSEY—Sixty-third annual report of the Department of Health, 1940. Trenton, N. J.

COUNTY OF ESSEX—Annual report of county engineer, Salem, Mass., 1940.

HACKENSACK, N. J.—Annual report of progress, 1941.

NEW YORK CITY HOUSING AUTHORITY—Eighth annual report, 1941.

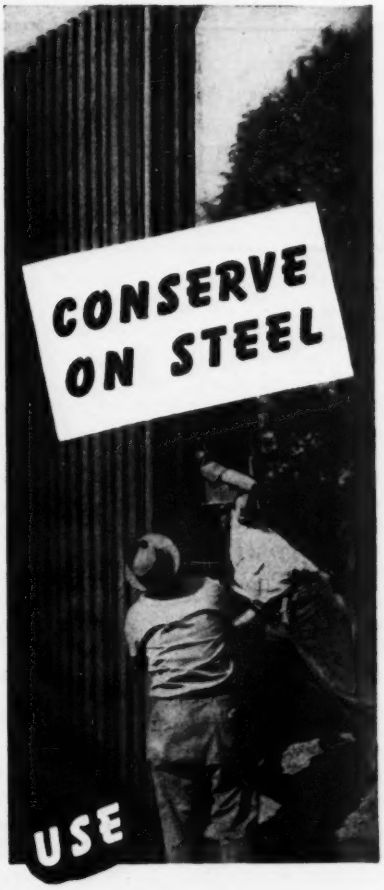
SYRACUSE, N. Y.—Annual report Department of Engineering, 1941.

SYMPOSIUM ON NEW METHODS FOR PARTICLE SIZE DETERMINATION IN THE SUB-SIEVE RANGE—American Society for Testing Materials, Philadelphia, Pa.

TABLE OF DISTANCES—Mississippi River from head of passes to Cairo and head of passes to Gulf of Mexico, 1941. Mississippi River Commission, Vicksburg, Miss.

INVESTIGATIONS OF THE IOWA INSTITUTE OF HYDRAULIC RESEARCH, 1939-1940. State University of Iowa, Iowa City. 40c.

(*Continued on p. 86*)



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Time, transportation, labor, power, steel—are all important items on any job—anytime. Conservation of all of them is vitally important today! Corrugated is designed to effect definite savings on them all. This unusual strong but lightweight corrugated piling is easy to transport and handle, easy to install, easy to salvage and reuse.

When figuring on your next job, be sure to have a Corrugated Steel Sheet Piling catalog before you. We'll gladly send you a free copy.

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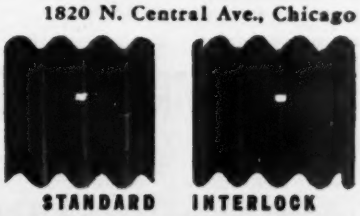


CORRUGATED
STEEL SHEET PILING

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

GRADE SEPARATION WASHINGTON, D. C.

OWNER: District Commissioners, District Building, Washington, D. C.

PROJECT: Constructing grade separation structures (overpass) in 14th Street, S.W., at Maine Avenue, Washington, D. C. Total length of main structure 1,570 ft. between end abutments and bridge structures at Maine Ave., the Outlet Channel and Hains Point Exit. Structures at Maine Ave. and Hains Point exit will be two span concrete rigid frames, the former 43 ft., and the latter 45½ ft. Outlet Channel bridge will consist of three span concrete rigid frame, each span 56-ft., and a three span continuous concrete girder ramp bridge. Various structures will be connected with stone faced concrete cellular construction. Entire superstructure, except concrete ramp girders, will be of reinforced concrete faced with stone masonry. Two vehicular roadways, 34-ft. each in width, to be separated by 4-ft. center curb.

CONDITIONS: Contractor to furnish all materials and complete work in 245 calendar days. Alternates were allowed on limestone and granite masonry for facing. Award made on former basis. Rail and highway transportation facilities available. Wage rates are: skilled labor, $1.50 to $2.00 per hr.; semi-skilled, 50 to 95c.; common, 85c.

BIDS: Five bids were received February 17, 1942, ranging from the contract low of $1,285,400 to $1,521,672. Engineer's estimate, $1,341,000.

LIST OF BIDDERS:

1. National Excavation & Structures Corp., New York.. $1,285,400
2. Charles H. Tompkins Co., Washington, D. C..... 1,287,745
3. Stock Constr. Corp., New York, N. Y..... 1,314,240
4. Lombardi Co., Inc., Philadelphia, Pa..... 1,359,380
5. George Vang, Inc., Pittsburgh, Pa..... 1,521,672

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Unclassified excavation	4,400 c. y.	$5.00	$8.00	$13.00
2. Remove old masonry and timber work	2,910 c. y.	33.00	20.00	22.00
3. Cast-in-place concrete piles	106,000 l. f.	3.00	3.15	2.70
4. Class BB concrete in footings	2,300 c. y.	24.00	17.00	27.00
5. Class BB concrete in neat work	3,130 c. y.	34.00	38.00	33.00
6. Class A concrete in neat work	5,600 c. y.	34.00	33.00	40.00
7. Class A concrete in roadway stringers	3,790 c. y.	34.00	36.00	40.00
8. Class A dressed limestone masonry	21,200 c. f.	5.00	4.90	3.40
9. Class A dressed granite masonry (Alt.)	21,200 c. f.	7.25	No. bid	4.60
10. Class B rubble masonry	21,500 c. f.	2.50	2.20	1.90
11. Reinforcing steel	2,550,000 lb.	.06	.065	.08
12. Metal handrail	3,150 l. f.	5.00	8.00	6.00
13. Spec. cast iron curb drain inlets	6,800 lb.	.20	.10	.15
14. Misc. iron and steel, roadway dams	120,000 lb.	.20	.18	.12
15. Bronze bearing plates	3,160 lb.	1.00	1.00	.60
16. 6-in. pipe connecting drain to sewer	460 l. f.	2.00	2.50	2.00
17. 8-in. pipe connecting drain to sewer	1,600 l. f.	3.00	3.50	2.75
18. Damp-proofing, in place	440 s. y.	1.00	.50	.60
19. Two-arms standards, rdwy. lighting	18 ea.	120.00	200.00	200.00
20. Single-arm standards, No. 6211-Y102	2 ea.	100.00	100.00	150.00
21. Single-arm standards, No. 6211-Y157	4 ea.	125.00	100.00	125.00
22. Flush-type parapet luminaires	16 ea.	50.00	100.00	100.00
23. Lighting conduit in place	550 l. f.	3.00	1.50	2.00

HIGHWAY, TEXAS

OWNER: Texas State Highway Dept., Austin, Tex.; D. C. Greer, state highway engineer.

PROJECT: Grading, culverts, flexible base, and double asphalt surface treatment of Highway No. 158, Taylor County, Tex., from one mile southwest of View, Tex., approximately 16 miles in southwesterly direction.

CONDITIONS: Contractor to furnish all materials and complete work in 175 working days. Rail and highway transportation facilities available. Wage rates are: skilled labor, $1.00 per hr.; semi-skilled, 50c; and common, 40c.

BIDS: Three bids were opened February 19, 1942, ranging from the contract low of $360,898 to $437,248.

LIST OF BIDDERS:

1. Morgan Constr. Co., T. M. Brown & Son, and W. S. Crawford, Dallas, Tex. (contract)..... $360,898
2. Thomas & Ratliff, Rogers, Tex..... 407,430
3. Cage Bros. & F. M. Reeves & Son, Bishop, Tex..... 437,248

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Clearing and grubbing	34.9 ac.	$0.35	$100.00	$100.00
2. Unclassified road excavation	258,776 c.y.	.50	.75	.75
3. Common and special borrow	15,980 c.y.	.23	.50	.40
4. Unclassified channel excavation	3,623 c.y.	.30	1.00	1.00
5. Unclassified structural excav	1,118 c.y.	2.00	3.00	4.50
6. Blading embankment (blade grader)	605 hr.	3.50	5.00	4.00
7. Blading embankment (bulldozer)	491 hr.	3.00	3.50	5.00
8. Overhaul	20,959 ½-mi. yd.	.10	.10	.10
9. Overhaul (selected mat'l.)	311,127 ½-mi. yd	.03	.05	.05
10. Sprinkling	14,730 M gal.	1.00	1.00	1.00
11. Rolling	2,632 hr.	2.50	2.50	3.00
12. Rolling (spec.)	605 hr.	3.50	3.50	4.00
13. Flexible base	105,288 c.y.	1.00	.60	.60
14. Add'l. quarter-mile haul	940,865 c.y.	.02	.02	.05
15. Prime coat (MC-1)	64,600 gal.	.09	.09	.10
16. Asphalt (OA-230)	129,400 gal.	.09	.09	.10
17. Aggregate	4,135 c.y.	3.50	3.25	4.00
18. Class A concrete	207.68 c.y.	20.00	25.00	30.00
19. Cl. A concrete for ext. struct	465.41 c.y.	20.04	30.00	35.00
20. Mortar rubble masonry	262.9 c.y.	15.00	15.00	15.00
21. Reinforcing steel	91,444 lb.	.055	.07	.06
22. Relay culv. pipe, over 18-in.	167.4 l. f.	1.00	3.00	2.00
23. Common mortar riprap	86 c.y.	8.00	6.00	10.00
24. 24-in. ext. str. rein. conc. pipe	164 l.f.	3.14	3.75	5.00
25. 30-in. ext. str. rein. conc. pipe	28 l.f.	3.96	4.50	5.50
26. 36-in. ext. str. rein. conc. pipe	90 l.f.	4.98	6.00	6.00
27. 42-in. ext. str. rein. conc. pipe	116 l.f.	6.15	8.50	7.00
28. 48-in. ext. str. rein. conc. pipe	84 l.f.	7.41	8.00	9.00
29. Concrete curb and gutter	244 l.f.	1.50	2.50	3.00
30. Right-of-way markers	38 ea.	2.00	3.00	2.00
31. Timber post guard fence	608 ea.	2.50	2.50	3.00
32. Remove and replace timber post guard fence	302 ea.	1.50	1.50	1.00
33. Grouted rock retards	188 c.y.	10.00	5.00	10.00

WATER MAINS, MICHIGAN

OWNER: Warren Township, Macomb County, Mich., and Defense Public Works Division of the FWA.

PROJECT: Construction of 34,860 feet of cast iron water mains in Warren Township, Macomb County, Michigan. Pipe sizes range from 6-in. to 16-in., and average depth of pipelaying 6 ft. No hard materials expected to be encountered in trenching. (Contract 5.)

CONDITIONS: Contractor to furnish all materials and complete work within 90 days after notice to proceed. Rail and highway transportation facilities available. Traffic congestion in vicinity of new defense plant may impede construction at times. Project was divided into several contracts, of which this is one, to enable smaller contractors to bid the work, and to obtain better range of competitive bids. Wage rates are: skilled labor, $1.625 per hr.; semi-skilled, $1.25; and common, 87½c.

BIDS: Twelve bids were opened January 27, 1942, ranging from the contract low of $129,103 to $149,427.

LOW BIDDERS:

1. Fattore Co., Detroit, Mich. (contract)..... $129,103
2. Waterway Constr. Co., Detroit, Mich..... 135,713
3. Santucci Constr. Co., Skokie, Ill..... 136,821

Item	Quan.	Unit Prices (1)	(2)	(3)
1. 16-in. cast iron water mains	7,515 l.f.	$4.88	$5.25	$5.40
2. 12-in. cast iron water mains	14,965 l.f.	3.27	3.38	3.39
3. 8-in. cast iron water mains	9,300 l.f.	2.15	2.24	2.11
4. 6-in. cast iron water mains	3,080 l.f.	1.75	1.60	1.64
5. Hydrants, gates and boxes	46 ea.	160.00	176.00	189.00
6. 16-in. gates and wells	7 ea.	350.00	370.00	355.00
7. 12-in. gates and wells	18 ea.	180.00	197.00	210.00
8. 8-in. gates and wells	27 ea.	132.00	148.00	155.00
9. 6-in. gates and wells	13 ea.	115.00	130.00	130.00

SAVES 4 WEEKS AND $8255

Contractor: Corbetta Construction Co., New York;
Architect-Engineer: Victor Mayper, New York

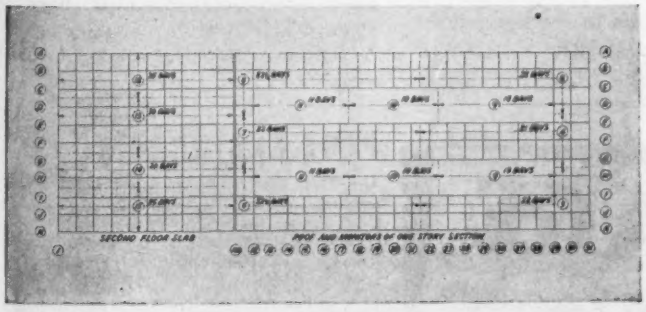
JOB SCHEDULE

POUR NO.	LOCATION		NUMBER OF BAYS	EXCAVATION, FOUNDATION, GRADE	FORM	REINFORCING AND TRAPS	CONCRETE	STRIP	REUSE AT
1		1ST FL.	32½	SEPT. 21	SEPT. 23-24	SEPT. 25	SEPT. 27	SEPT. 30	3-4
2		1ST FL.	32½	" 23	" 25-26-27	" 26-27	OCT. 1	OCT. 2	4-5
3		ROOF	22	-	SEPT. 30 OCT. 1	OCT. 1-2	" 2	" 4	6
4			21	SEPT. 30	OCT. 1-2	" 2-3	" 3	" 7	7
5	ONE STORY BUILDING		22	OCT. 2	" 3	" 4	" 7	" 9	8
6			22½	" 3	" 4	" 7	" 8	" 10	9
7			22	" 5	" 7-8	" 8	" 9	" 11	9-10
8			22½	" 8	" 9	" 10	" 11	" 14	10-11
9		MONITOR	26	-	" 10	" 11	" 14	" 16	12
10			20	-	" 11	" 14	" 15	" 17	12-13
11			22	-	" 14-15	" 15	" 16	" 18	13
12	TWO STORY BLDG	2ND FL.	25	OCT. 15	" 16	" 17	" 18	" 21	14
13			30	" 16	" 17-18	" 18-21	" 22	" 24	15-16
14			20	" 18	" 21	" 22-23	" 24	" 28	17
15			25	" 22	" 24	" 25	" 28	" 30	18
16		ROOF	18	-	" 25	" 28	" 29	" 31	19
17			32	-	" 28	" 29	" 30	NOV. 1	19
18			26	-	" 30	" 31	NOV. 4	" 6	-
19		MONITOR	24	-	OCT. 31 NOV. 1	NOV. 4	" 5	" 7	-

FLOORS ON EARTH ONE STORY BLDG MIX. END NOV. 1
FLOOR " " 2-STORY " " " " 9

BASIS OF SCHEDULE:
FORMS ARE FURNISHED FOR 68 BAYS. 'INCOR' CEMENT TO BE USED, PERMITTING COMPLETE STRIPPING 2ND MORNING AFTER POUR. THE 68 BAYS ARE USED FOR 3 DAYS POUR WITHIN SAME CALENDAR WEEK. ALL BAYS FOR GIRDERS, BEAMS AND SLABS ARE COMPLETELY REUSABLE EVERYWHERE.

Utilizing 'Incor's 24-hour service strength and forming only 15% of the area, a carefully prepared progress schedule enabled Corbetta Construction Co., Inc., to complete this factory building in record time—at minimum cost. This job shows that form economies are possible on one- and two-story buildings as well as on multi-story structures.



Planning with 'Incor' Produces Top Speed at Minimum Cost

SPEED is the need of the hour. Good job planning and 'Incor' 24-Hour Cement save vital weeks and often reduce construction costs.

As a result of careful planning, Crawford Clothes factory, occupying an entire city block in Long Island City, New York, was completed in record time—at minimum cost.

Corbetta Construction Co., Inc., general contractors, estimated this one- and two-story building, of reinforced concrete beam-and-girder design, on the basis (1) of forming 50% of the required area, or (2) by using 'Incor' 24-Hour Cement and forming about 15% of the area. Either method meant a time saving of about 4 weeks over usual schedules. *But 'Incor' showed a net cost saving of $8255, as against the extra forms needed for the same construction speed.*

'Incor'* was used in the frame; elsewhere Lone Star was used. The job was completed in record time—faster speed at lower cost. Write for copy of "Cutting Concrete Costs." Lone Star Cement Corporation, Room 2284, 342 Madison Avenue, New York.

*Reg. U. S. Pat. Off.

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(*Continued from p. 83*)

ANALYSIS OF HIGHWAY COSTS AND HIGHWAY TAXATION WITH AN APPLICATION TO STORY COUNTY, IOWA. Bulletin 152, Iowa State College, Ames, Iowa.

DESTRUCTION OF TIMBER BY MARINE ORGANISMS IN THE PORT OF SIDNEY—Supplementary Report No. 2. Maritime Services Board of New South Wales, Sydney, Australia.

GROUND-WATER TEMPERATURE ON LONG ISLAND—As Affected by Recharge of Warm Water. U. S. Geological Survey, Jamaica, N. Y.

ANALYSIS OF SKEW SLABS—Engineering Experiment Station, University of Illinois, Urbana, Ill. $1.

TESTS OF CYLINDRICAL SHELLS—Engineering Experiment Station, University of Illinois, Urbana, Ill. $1.

HYDRAULICS OF VERTICAL DRAIN AND OVERFLOW PIPES—Reprints in Engineering. University of Iowa, Iowa City.

PROSPECTIVE AND REMEDIAL MEASURES FOR SANITARY AND PUBLIC HEALTH ENGINEERING SERVICES—American Society of Civil Engineers, 33 West 39th Street, New York.

LIST OF INSPECTED FIRE PROTECTION EQUIPMENT AND MATERIALS—January, 1942, Underwriter's Laboratories, Inc., 207 East Ohio St., Chicago.

HIGHWAYS THEN AND NOW: Milestones in the Development of Modern Roads—Extension Series No. 52, Purdue University, Lafayette, Ind.

A STUDY OF THE POLLUTION AND NATURAL PURIFICATION OF THE SCIOTO RIVER—Bulletin No. 276, U. S. Public Health Service, Washington, D. C.

EMPLOYEE ORGANIZATION FOR FIRE SAFETY—National Fire Protection Association, Boston, Mass.

POST-DEFENSE READJUSTMENTS—Construction and Civic Development Department, Chamber of Commerce of the United States, Washington, D. C.

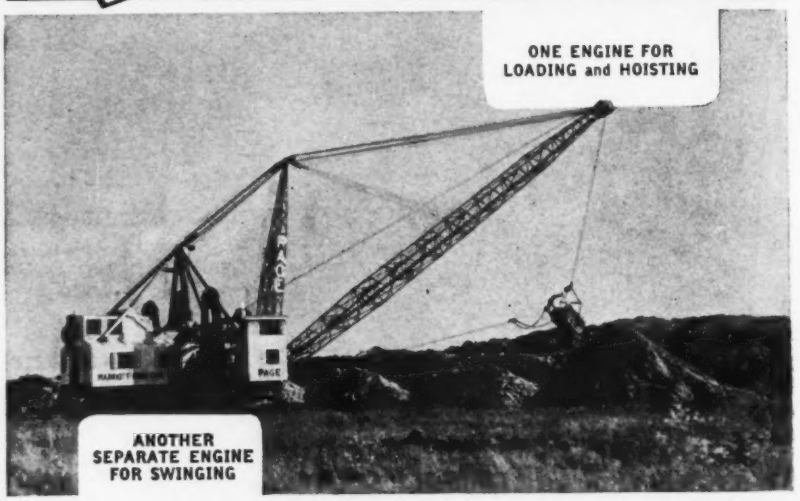
HANDBOOK OF FEDERAL LABOR LEGISLATION—Bulletin No. 39, Part 2. Labor Laws of General Application. Superintendent of Documents, Washington, D. C. 30c.

A HANDBOOK ON URBAN REDEVELOPMENT FOR CITIES IN THE UNITED STATES—Superintendent of Documents, Washington, D. C. Price 15c.

BUILDING MATERIALS AND STRUCTURES—Properties and Performance of Fiber Tile Boards, (10c.); Structural, Heat-Transfer, and Water-Permeability Properties of Five Earth-Wall Constructions, (20c.); Water-Distributing Systems for Buildings, (15c.). Superintendent of Documents, Washington, D. C.

Fast

PAGE TWO-ENGINE DIESEL-POWERED WALKING DRAGLINE



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Visualize using ALL the power of your present dragline for *hoisting.* ONLY . . . without swinging the machine. Hoisting speed would be greatly increased. Now consider a second, independent engine for *swinging,* ONLY. Swing is speeded up in proportion to the faster hoist —the result: MORE YARDAGE HANDLED PER SHIFT.

The Page TWO-ENGINE Walker gives you FAST HOIST and FAST SWING—*at the same time.* It is a miracle of balanced power, speed and flexibility. Even with its TWO Page Horizontal Diesel Engines—it is amazingly compact and economical to operate. Get the facts about a Page TWO-ENGINE Dragline for YOUR job. Mail the coupon below —TODAY!

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Mail a copy of your new folder "Page Walking Draglines On the Job" with NO obligation to me.

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Laying a 24 inch pipe line

OVER MOUNTAINS TOO STEEP FOR TRACTORS

A NEW copper smelter needed thousands of gallons of water a minute. The nearest large water supply was 7 miles away and over rugged pipe line terrain. Mountains with slopes up to 45 degrees—too steep for tractors to climb. The water was so corrosive it was decided that ordinary pipe could not be used. Operating pressures would be high, with the possibility of becoming higher if the capacity of the line were increased.

24-inch NATIONAL Seamless Duroline Pipe was selected for the high-pressure end of the line laid over the mountains. Seamless—"Walls Without Welds"—will give the needed strength for the severe service conditions imposed; Duroline will give the necessary corrosion resistance because it is impervious to the effects of corrosive water.

Many of the slopes were so steep that the pipe had to be snaked into position with an engine anchored on top of the mountain. Funnel-shaped caps made of steel boiler plates were placed over the ends of the pipe to hold the wire lines and to protect the pipe and lining. In spite of all this unusual handling, Duroline Pipe came through in excellent condition.

This is a typical instance of how seamless steel pipe is able to meet unusual installation conditions—NATIONAL *Seamless is America's Preferred Pipe for Water Lines.*

NATIONAL TUBE COMPANY

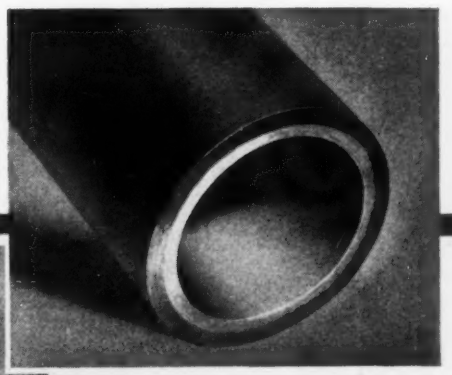
PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York

UNITED STATES STEEL

Laying a 24-inch water line over a mountain with a 45° slope. Because the water was highly corrosive, NATIONAL *Duroline Pipe was used.*

NATIONAL DUROLINE — Strong steel pipe with corrosion-proof lining.



EAMLESS MEANS MAXIMUM SECURITY

Ahead of the

BEFORE the huge new Flying Fortresses, medium bombers and bullet-swift pursuit ships of our growing Air Force can be used to full advantage, they must have broad and level landing fields.

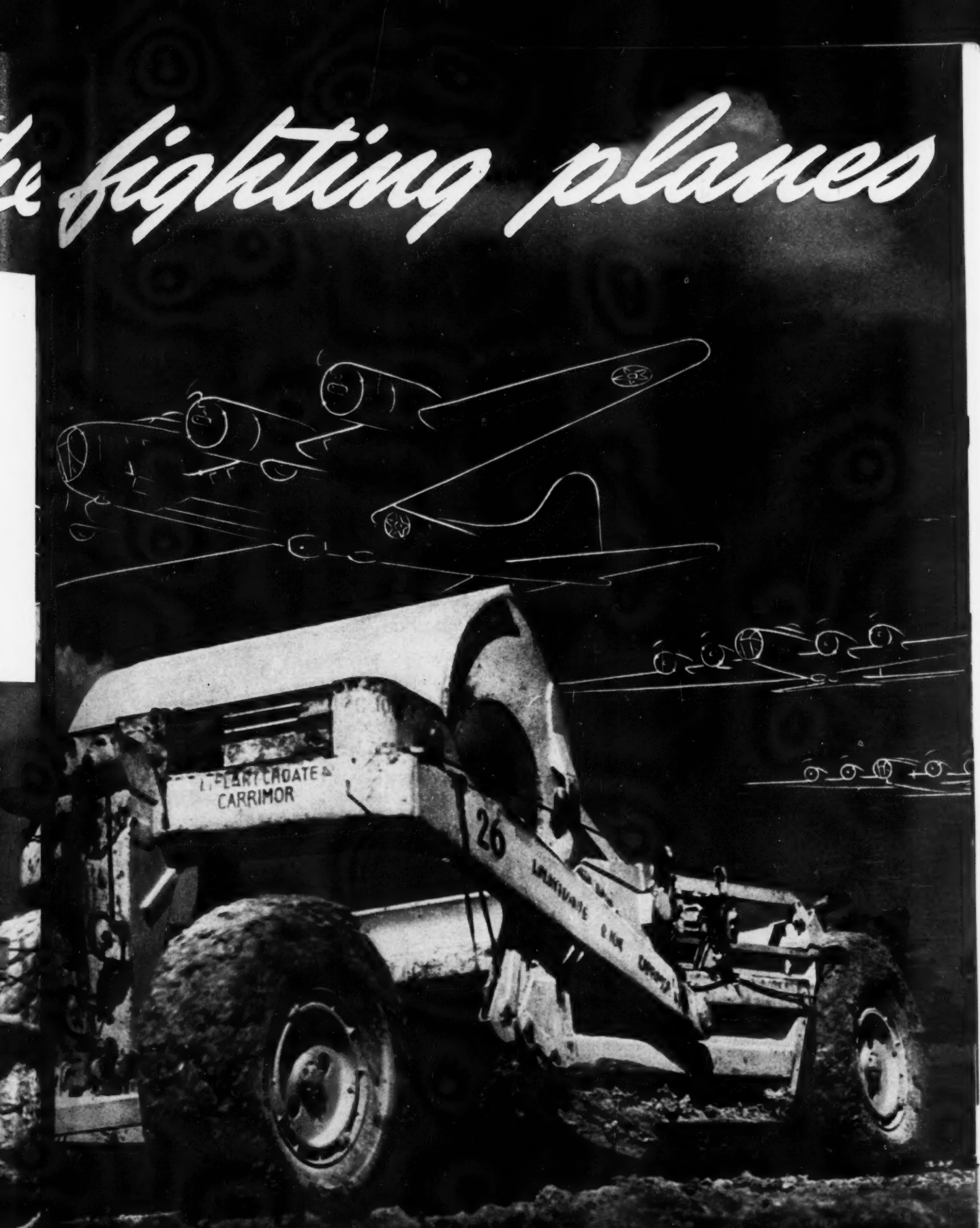
Those fields are being built today. Out of raw desert, forest and farmland, long runways are emerging swiftly. By the time the new planes and their pilots are ready, bases by the hundred will be waiting for them.

How is this tremendous task being accomplished? By the same tough "Caterpillar" Diesel Tractors, Engines and Motor Graders that have given America so many other advantages worth fighting for. In less than two years these brawny machines have done an unprecedented earth-moving job. Leveling hills and filling valleys, hauling giant scrapers and wagons, they have shifted countless millions of tons of dirt and rock to build highways, military and naval bases, air fields, industrial plants and shipyards.

The power, versatility and rugged stamina of "Caterpillar" Diesel equipment are vital factors in the nation's present effort. And they will be ready to help build a better world when the war is won. Caterpillar Tractor Co., Peoria, Illinois.

TO WIN THE WAR: WORK — FIGHT — BUY DEFENSE BONDS!

...e fighting planes



CATERPILLAR *DIESEL*

REG. U.S. PAT. OFF.

ENGINES AND ELECTRIC SETS • TRACK-TYPE TRACTORS • ROAD MACHINERY

To help you *Speed up* essential construction

TIME is precious. Here—available on the proper priorities—are basic construction materials that have been used by engineers and contractors in establishing all-time records for speedy installation. Their dependability is thoroughly established. So far as it is within our greatly increased capacity these necessary materials will be forthcoming to help you meet the rapid expansion of war construction that lies ahead.

U·S·S Steel Bearing Piles. For safe foundation under buildings, bridges, viaducts, dams, piers and docks, these easily driven H-Piles are time and money savers. Their capacity for high unit loads, both vertical and horizontal, permits fewer driving operations for a given load. Readily handled in the field by ordinary equipment, they are easy to splice, withstand rough handling, eliminate jetting, and require minimum space in transport and storage.

U·S·S Steel Sheet Piling. In straight-web, arch-web and Z-sections, drive easily, can be readily pulled and salvaged, a rugged, lasting product, ready to be handled and driven under the most difficult conditions of soil, water and surf. Particularly useful for speeding up construction of bridge piers and abutments, bulkheads, and retaining walls, cofferdams, trench sheathing, docks and wharfs.

U·S·S I-Beam-Lok. Fast and easy installations distinguish this lightweight, heavy-duty steel bridge flooring. Also recommended for the rapid construction of heavy-duty factory floors, ramps, wharfs, docks and similar structures subjected to heavy loads and high-speed traffic. By saving weight in the floor, you can save steel in the supporting structure. More than 4,000,000 sq. ft. of I-Beam-Lok have been applied to put new life into old bridges and make new ones last longer. Available both in Open and Concrete-Filled types.

U·S·S Corrugated Culverts. High drainage capacity, ease and speed of installation without skilled labor makes these superior culverts ideal for highway and railroad drainage, for small bridges, for all types of sewers and wherever ground water must be run off in a hurry. Most jobs can be completed without forms or shoring. Even the heaviest plates for large culverts are easily handled by ordinary labor and without special tools.

U·S·S Concrete Reinforcing Bars. Made full size, cleanly rolled from new billet steel to standard specifications. These well-known bars are indispensable where strength is necessary in concrete work. Distributors located in all principal cities insure least delay in delivery.

* The cooperation and assistance of our engineers is available not only in applying these materials most efficiently to your designs, but we are prepared to work with you in figuring out alternate construction that, wherever possible, will save steel for other vital national requirements.

CARNEGIE-ILLINOIS STEEL CORPORATION

Pittsburgh and Chicago

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*

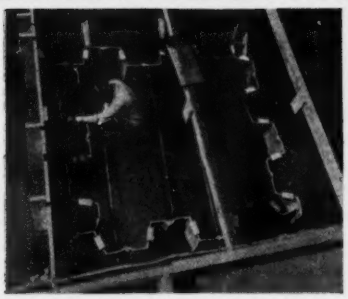
United States Steel Export Company, New York

STEELS THAT MEET THE CHALLENGE OF TODAY AND TOMORROW

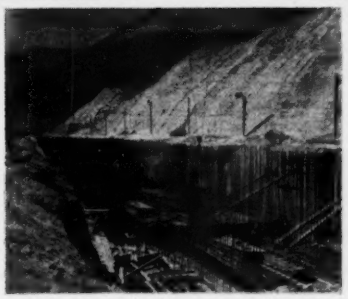
USS

UNITED

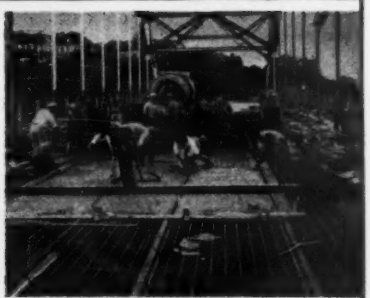
For efficient draining of airports, army camps, railroad sidings and highways, U·S·S Corrugated Culverts and Sectional Plates for Culverts cover practically every requirement. Simplicity of design, easy handling and installation, light weight and great strength combine to save time and labor costs.



For dams, docks, wharfs and sea-dromes. Wherever such work is being rushed to swift completion, U·S·S Steel Sheet Piling is doing its share in speeding up construction. Quickly assembled, easily driven, each unit positively interlocked with the next, it provides, for both permanent and temporary construction, a material that offers the double advantage of speed and economy.



Adding strength to gun emplacements, bridge piers, abutments, retaining walls, etc. Enormous quantities of U·S·S Concrete Reinforcing Bars are going into such construction. Engineers and contractors are finding them the most economical and practical means of obtaining strength and thoroughly reliable reinforcement for concrete construction that must be placed with least delay.



For building and strengthening strategic bridges to meet military needs, we recommend U·S·S I-Beam-Lok *Open Flooring*. Though it weighs only 18.6 lb. per sq. ft., this all-steel floor can be applied directly to stringers on spacings up to 4′ centers to permit H-20 loading. Is fire-safe, anti-skid and self-cleaning. The large size of units, 6′2″ wide up to 49′ long, makes fast erection possible.

S T A T E S S T E E L

WEST DODD HELPS

KEEP 'EM ROLLING!

—BY STANDING GUARD AGAINST LIGHTNING!

★ On U. S. powder magazines, arsenals, and ammunition loading lines . . . on power stacks and the buildings of many factories where the tools of victory are being forged . . . West Dodd Lightning Protection and static control equipment is doing its bit.

And the reason? Simply a case of playing safe. For records of the National Board of Fire Underwriters' prove that lightning causes a lot of damage . . . is a leading source of fire. Yet there is nothing against which you can be more certain of protection.

West Dodd . . . oldest manufacturer of lightning protection equipment . . . builds systems for all purposes, carrying the approval of the National Board of Fire Underwriters', American Institute of Electrical Engineers, and other competent authorities. West Dodd lightning protection equipment is inspected and labeled in the plant by Underwriters' Laboratories, Inc. *Immediate delivery.* Write for the details today.

FREE The West Dodd Engineering Dept. will be glad to assist in planning application, or estimating costs.

WEST DODD
LIGHTNING CONDUCTOR CORP.
A RELIABLE PROTECTION AGAINST A LEADING CAUSE OF FIRE
D/S
GOSHEN, INDIANA

MEETINGS

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, annual meeting, Hotel Gibson, Cincinnati, Ohio, April 13–17.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, annual meeting, Ambassador Hotel, Atlantic City, N. J., April 16–18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, Spring meeting, Hotel Roanoke, Roanoke, Va., April 22–23.

AMERICAN SOCIETY OF PLANNING OFFICIALS, Indianapolis, Ind., May 24–28.

REGIONAL AND LOCAL MEETINGS

NEW ENGLAND WATERWORKS ASSOCIATION, Hotel Biltmore, Providence, R. I., April 23 (in conjunction with the New England Health Institute).

ENGINEERING SOCIETY OF WISCONSIN, 34th annual convention, Appleton, Wis., March 26–27.

MONTANA SECTION, AMERICAN WATER WORKS ASSOCIATION, Helena, Mont., April 16–17.

NEW ENGLAND WATER WORKS ASSOCIATION, Manchester Country Club, Manchester, N. H., May, 1942. (Date to be announced.)

NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS, annual convention, Hotel New Yorker, New York, N. Y., May 14–16.

Elections and Activities

MEMBERS of the Minnesota Federation of Architectural and Engineering Societies in a recent convention at Minneapolis recommended immediate steps by the War Department to protect the nation's principal source of iron ore supply from the possibility of aerial attack. The resolution pointed out the strategic importance of the Great Lakes area as an ore producer and as an electrical power producing area.

R. M. ROTHGEB has been elected president Raleigh (N. C.) Engineers Club, other officers include Wade Gallant, vice president, and Sam Wilson, secretary-treasurer.

ELMER J. SPERLING, Jacksonville, Fla., been elected secretary of the Engineering Professions Club, succeeding Richard L. Lampp, who resigned recently.

The MILWAUKEE chapter of the Associated General Contractors of America elected E. P. Berghammer, T. H. Bent-

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YS A WEEK. IT OPERATES AHEAD OF ONE 34E SINGLE
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R-B POWER FINEGRADER

here comes AN R-B FINEGRADER!

PICTURE it yourself — one machine with one operator cutting grade fast enough to keep well ahead of both a single drum and a double drum 34-E paver putting down 350 feet of concrete per hour. That's really rolling and that's the reason so many of the nation's leading contractors use Buckeye R-B Power Finegraders. These machines cut the grade right on the nose — to the exact cross-section desired. They eliminate the grade-building bottleneck, save time and money and manpower to speed vital military roads and airports to completion ahead of schedule. They're virtually an essential on today's forced draft projects. Put an R-B Finegrader to work on your next road or airport job and you'll never try to get along without one again.

Write for New Bulletin.

THE BUCKEYE TRACTION DITCHER COMPANY, Findlay, Ohio

Built by Buckeye

Convertible Shovels

Trenchers

Tractor Equipment

R-B Finegraders

Road Wideners

Spreaders

Fairbanks-Morse dual-drive pumping unit which has given standout performance in the Franklin, New Hampshire, pumping station.

Motor-driven Pump Wins Over Water-powered Triplex!

You'd say it would take an outstanding motor-driven pump to compete successfully with a water-wheel-driven triplex on New England's rushing Merrimac River. Yet a modern Fairbanks-Morse Pump has *won* in exactly such a competition in the Franklin, New Hampshire, pumping station.

The F-M Pump, a 4" double-suction centrifugal, was installed more than two years ago, merely as a stand-by. But it proved so economical and efficient that it is being given more and more of the work.

Dual drive prepares this pump for any emergency. At one end of the common base is a 50-hp. F-M Type "Q" Motor; at the other end, a 65-hp. F-M Gasoline Power Unit. Thus responsibility for every part of the compact, well-integrated unit is concentrated in one manufacturer.

Whatever the nature and scope of *your* pumping problem, the complete F-M line includes just the pumps to serve you with outstanding economy and dependability. Our engineers are at your call, without cost or obligation. Write Fairbanks, Morse & Co., Dept. C29, 600 S. Michigan Ave., Chicago, Illinois. Branches and service stations throughout the United States and Canada.

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DIESEL ENGINES · PUMPS · ELECTRICAL MACHINERY · MAGNETOS · FAIRBANKS SCALES · MOTORS · STOKERS · WATER SYSTEMS · WASHERS-IRONERS · FARM EQUIPMENT · RAILROAD EQUIPMENT · AIR CONDITIONERS

F-M Pumps

ley, T. L. Cottam, H. F. Mielenz and W. T. Buckholz as directors at an annual meeting held recently.

HOMER HUNTER, superintendent of the Dallas Municipal water works department, has been elected president of the Dallas unit of the Am. Soc. C. E. Other officers are: E. L. Meyers, vice president; J. L. O'Hearne, secretary, and Frank Maryine and T. E. Hoffman, directors.

RAYMOND J. ASHTON, of Salt Lake City, has been elected president of the Utah Building and Construction Congress. Other officers elected included: John H. Moser, of Logan, Ora Bundy, of Ogden; Gilbert W. Williams of Salt Lake City; O. A. Spear of Provo, and Arthur Jones, of Cedar City, vice presidents; R. A. Hart, of Salt Lake City, secretary-treasurer.

The PHILADELPHIA section, Am. Soc. C. E., in conjunction with the Portland Cement Association, is holding a series of lectures for engineers interested in latest developments in the field of concrete design and construction. Meetings on specific subjects are scheduled for March 31, April 14, April 28, and May 12.

R. S. PHILLIPS, of Durham, N. C., secretary of the North Carolina Section of the American Water Works Association, and of the North Carolina Sewage Works Association, has announced that the groups will hold their 22nd annual joint convention in Durham, Nov. 2-4.

ALEX HANCOCK, of Mobile, has been reelected president of the Alabama Road Builders Association, which held an annual meeting recently in Mobile. All other officers of the organization were reelected.

MEN AND JOBS

E. R. Jacobsen, civil engineer for the Dominion Bridge Co., Ltd., of Montreal, Canada, has been appointed personal assistant to L. R. Macgregor, director-general of the recently formed Australian War Supplies Procurement Board at Washington, D. C.

David D. Clerk, formerly chief engineer of the Drainage Office of the Province of Quebec Department of Agriculture, has been appointed president of the office.

Georges Proulx has been appointed chief engineer of the city of Chicoutimi, Province of Quebec, Canada.

A. Reese Harvey has been appointed office engineer in the Alabama Highway Department, at Montgomery, succeeding W. G. Pruett, who was recently appointed

"The Navy gave them to us for Production Excellence"

They're owned by 7000 people who pulled together, working hard

"Out there on the Roebling staff you see two emblems. The top one, bearing the crossed cannons, is the Naval Ordnance flag. And below that is a pennant, "E" ... the United States Navy's flag of Excellence. The Navy "E" is something to be strived for—at sea, in peacetime, officers and men must work all year to reach the standard of excellence that bestows an "E" on a stack, for engineering; on a turret, for gunnery; on a radio shack, for communications. Ashore, it's given with the Ordnance flag for another kind of excellence—the kind you get from seven thousand heads and fourteen thousand hands that Roebling stands for ... Production Excellence.

When the Navy gave these flags to Roebling, they also pinned an "E" on every man-jack of the Roebling crew. You'll see it proudly worn by the men who are today filling your wire rope needs. They're working with the pride and satisfaction of master-craftsmen, knowing they have pleased one of the world's most demanding customers, just as they'll please you.

The men who man the open hearths are putting something extra into every melt of Roebling "Blue Center" Steel. Something they gained the day they got their "E", when they watched these same hearths swallow a fragment of enemy bomb from the hand of a Naval officer, to be returned with interest to those who menace American liberty.

You'll get that "something extra" if you're in the Navy, using Roebling Wire Rope for any one of its multitude of shipboard purposes, such as the slings that hoist a plane aboard its mother ship.

You'll get it also if you're buying Roebling "Blue Center" for any of the vital industrial uses that must go night and day, non-stop ... for logging camps, for mines or elevators, for plant hoists or oil well drilling lines. You'll get it every time you use the Roebling trade-mark as your buying guide."

JAR ROEBLING

Roebling Research, plant facilities; Roebling Quality Control and Engineering ... for years they've been putting extras into "Blue Center" Wire Rope. Extras that you need today, wherever wire rope has a dependable, long-lived job to do.

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TRENTON, NEW JERSEY
Branches and Warehouses in Principal Cities

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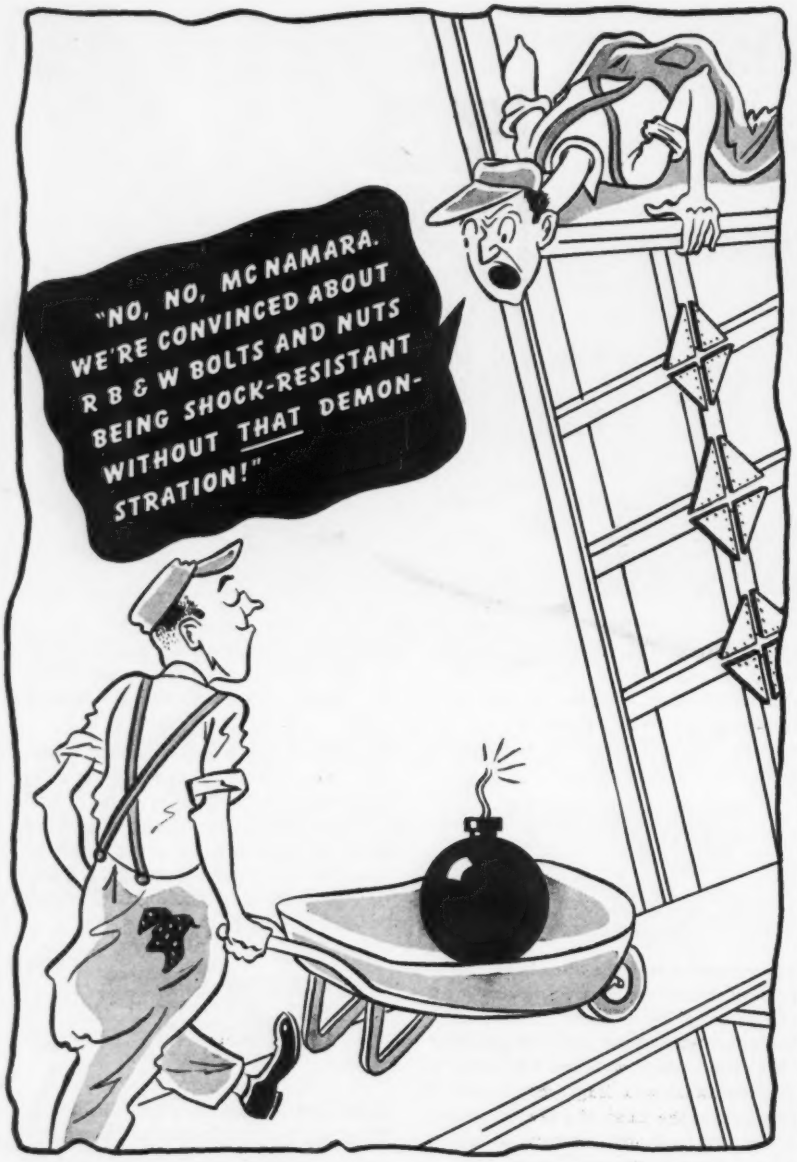
"Blue Center"
STEEL WIRE ROPE
PREFORMED OR NON-PREFORMED



Use R B & W Bolts and Nuts . . .

Quick-starting, quick-tightening because they are accurately, uniformly sized and threaded — and carefully inspected.

Vibration-resisting, shock-resisting because the manufacturing method insures extra strength, and all processing is controlled from raw rod to finished product.

EMPIRE BOLTS NUTS RIVETS AND ALLIED FASTENING PRODUCTS . . . SINCE 1845

RB&W *Making strong the things that make America strong*

Russell, Burdsall & Ward Bolt and Nut Company. *Factories at* Port Chester, N. Y., Rock Falls, Ill., Coraopolis, Pa.; *sales offices at* Philadelphia, Chicago, Detroit, Chattanooga, Los Angeles, San Francisco, Portland, Seattle

director. Mr. Harvey has resigned as a director of the State Planning Commission in order to fulfill his new duties.

Maurice Archambault, a civil engineering graduate of the Ecole Polytechnique of Montreal and now chief chemist for the Province of Quebec Department of Mines, has been appointed professor at Laval University, Quebec.

John M. Long, formerly a partner of the contracting firm of Reichenbach & Long, Northumberland, Pa., has resigned to become superintendent of construction for the F. D. Kessler Co., also of Northumberland.

H. Wesley Clark, city engineer of Niagara Falls, N. Y.,, has been appointed acting city manager to fill the vacancy left by the death March 7 of William Robbins.

Robert F. Holly has been named supervisor of the TVA reservoir clearance office recently set up at Bryson City, N. C., to clear the Fontana dam reservoir area.

Charles Langlois has been appointed assistant engineer, District No. 1 for the Province of Quebec Department of Roads.

Percy Bloxam, engineer and city manager of Roxboro, N. C., has been appointed one of three special recruiting officers in North Carolina for the U. S. Navy.

Elmer W. Gain, associate engineer for the U. S. Soil Conservation Service and for the past several years assistant drainage engineer of the Ohio Valley Regional Office, has been transferred to Fowler, Ind., as engineer assisting soil conservation districts in northwestern Indiana.

C. V. Armstrong, research associate and assistant bulletin editor of the Iowa State Engineering Experiment Station at Ames, Iowa, has left that post to join the Standard Oil Development Co. of Elizabeth, N. J.

G. W. Holder, formerly manager of the Sturgeon Falls Division of the Abitibi Power Co., Ltd., has been transferred to the engineering department of the company's Sault Ste. Marie mills.

Dana Young has resigned as head of the civil engineering department of the University of Connecticut, to become professor of applied mechanics at the University of Texas.

H. A. Crombie, assistant manager of the Dominion Engineering Co., Ltd., Montreal, has been appointed administrator

SMITH

Faster MIXING CYCLE.

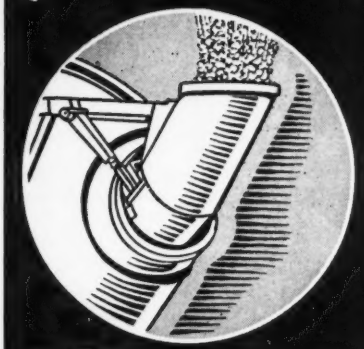
Speeds Up Big Concrete Projects!

Excelling in every phase of the batch cycle — *charging, mixing, discharging* — SMITH TILTERS are helping to complete big concrete projects in record breaking time. There are the three TVA projects, for example. Cherokee and Watts Bar Dams completed in 1941 — and Fort Louden Dam, *months ahead of schedule.*

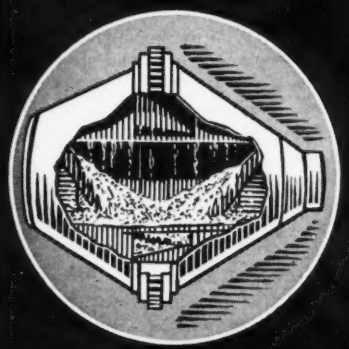
The Smith automatic "straight-flow" feed chute shoots the materials directly to the center of the drum. Mixing is faster because the drum rotates in practically a horizontal position with converging blades producing a *real end-to-center mixing action.* The big drum opening and steep 60° drum tilt assures faster discharge.

If you're looking for the fastest, most modern concrete mixers, be sure to investigate SMITH TILTERS. All sizes available, up to 4-yards per batch. Write for catalog.

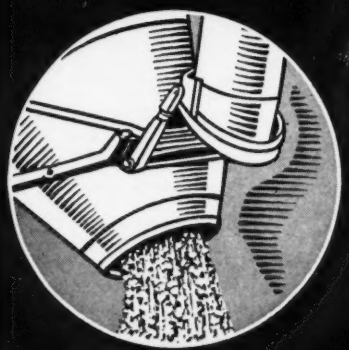
The T. L. SMITH CO., 2855 N. 32nd St., Milwaukee, Wis., U.S.A.



IN *FASTER*



MIX *FASTER*



OUT *FASTER*

New, improved Smith Tilter with all-welded box girder pedestals and tilting frame . . . Machine cut, heat-treated, high-carbon steel gears . . . Forged, heat-treated drum rollers . . . Fully enclosed transmission unit . . . Direct connected motor . . . etc.

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GOHI PIPE
CORRUGATED

Reclamation project

Stream diversion frequently requires a major operation, but in this installation GOHI Pipe solved the problem easily and permanently. The water is confined to its original course and a valuable building site preserved and safeguarded. Whatever your drainage problem, look to GOHI Pipe for the answer.

Consult the fabricator located nearest you, and ask for copy of 72-page book on modern drainage practice. It's FREE.

New England Bolt Co.	Everett, Mass.
Central Culvert Co.	Ottumwa, Iowa
Capital City Culvert Co.	Madison, Wisc.
Bancroft & Martin Rolling Mills Co.	S. Portland, Me.
Denver Steel & Iron Works Co.	Denver, Colo.
The Lane Pipe Corporation	Bath, N. Y.
Dixie Culvert Mfg. Co.	Little Rock, Ark.
St. Paul Corrugating Co.	St. Paul, Minn.
The Newport Culvert Co.	Newport, Ky.

GOHI Pipe meets Copper-Bearing Pure Iron requirements in all specifications published by nationally recognized specifying authorities.

GOHI CULVERT MANUFACTURERS, INC.,
NEWPORT, KY.

of plant machinery, equipment and supplies for the Wartime Prices and Trade Board with offices in Montreal.

William H. Hall, assistant city engineer at Oklahoma City, Okla., has resigned to join the teaching staff of the Oklahoma A & M College at Stillwater.

Harvey L. Hooke, of West Hartford, Conn., has been appointed chief engineer of the War Industry Conversion Board to be named soon by Governor Robert A. Hurley.

F. H. Dechant, of the firm of William H. Dechant & Sons, Reading, Pa., has been called to active duty with the United States Navy.

John Schofield, architect for Canadian National Railways has been appointed chief architect of the entire system.

F. W. Spencer, of Southport, N. C., is supervising the construction of a municipal power plant building at Southport.

C. C. Lindsay, Montreal consulting engineer and land surveyor has been appointed a member of the Montreal Tramways Commission.

Walter L. Rice, formerly senior assistant engineer of the Works and Buildings Department of Montreal, Canada, has been commissioned a flying officer in the Royal Canadian Air Force.

H. E. Palmer of Wadena, Minn., has been named county engineer for Dakota County with headquarters at Hastings.

William D. Williams, a consulting engineer of Stillwater, Minn., is engineer in charge of sanitation and water supply at a proposed defense plant near Wahoo, Neb.

Philip Harper, of Lincoln, Neb., has been named state airport engineer by the Nebraska Aeronautics Commission. He succeeds L. E. Tyson, who recently was called to active service in the U. S. Army Air Corps.

Neil Brown, of Estherville, Iowa, and formerly assistant county engineer for Emmett County, is now an engineer for the Iowa State Conservation Commission.

J. H. Hamel, formerly assistant engineer for the Quebec Harbour Commission is superintendent and engineer for E. G. M. Cape & Co., contractors of Montreal at St. Johns, Newfoundland.

Kenneth C. Lauster, associate sanitary engineer in the North Dakota State Department of Health at Bismark, has been appointed acting director of the Divi-

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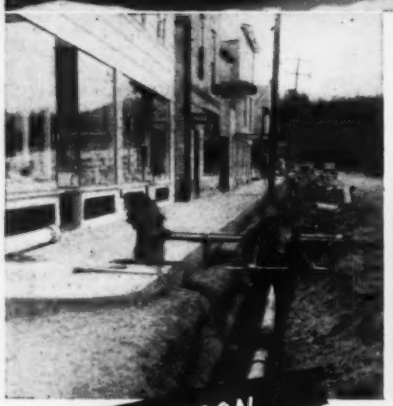
The "ULTIMATE LOW COST WIRE ROPE"

Outstanding Union Wire Rope distributors throughout the country are backed up by two important forces for your convenience: (1) strategically located warehouses to insure prompt service, and (2) trained rope engineers available at all times to help solve your rope problems. This Service Map is your guide. Tear it out and keep it in your files to facilitate your future use of wire rope.

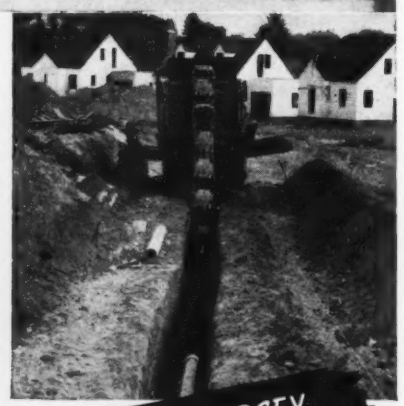
UNION WIRE ROPE CORPORATION

ALL OVER

TEXAS


OREGON

NOTICE
TAKE NOTHING FROM
CITY PROPERTY
WITHOUT REQUISITION
NEW MEXICO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THE COUNTRY!

In hundreds of communities, J-M Transite Pipe is providing more efficient water transportation at lower cost. *Here are the reasons why—*

Easy to Handle, Transite is light in weight, comes in 13-foot lengths. Except for the largest sizes, no mechanical equipment is needed.

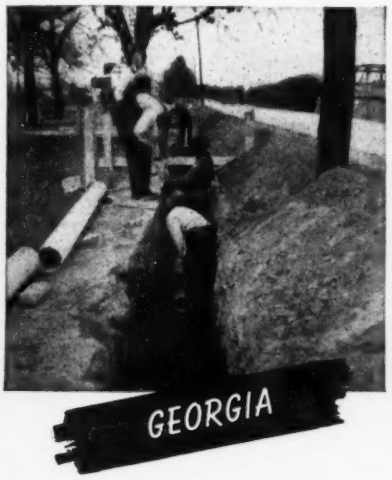
Rapid Assembly is assured by the Simplex Coupling, a pre-fabricated, "packaged" joint that eliminates heating or pouring. Unskilled crews can form tight joints quickly, easily.

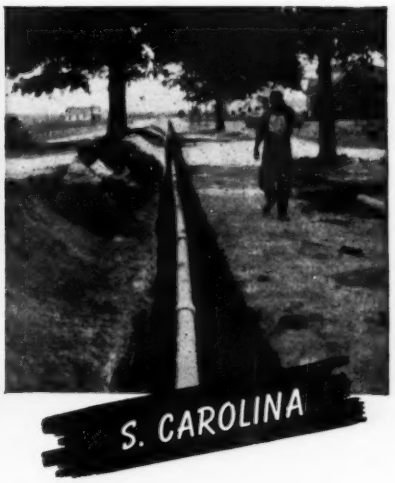
Tuberculation Is Impossible because Transite is made of asbestos and cement, non-metallic. Its initial high flow-coefficient (C=140) can never be reduced by tubercles.

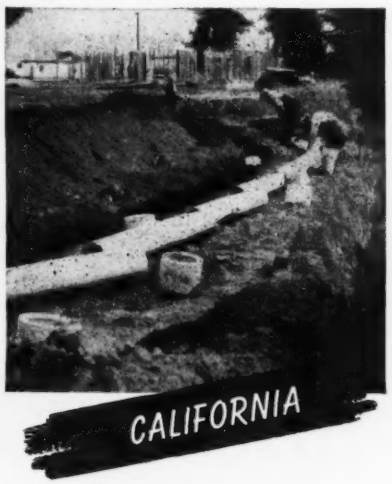
High Corrosion-Resistance is another feature of Transite's asbestos-cement composition.

Joint Leakage Minimized by the tightness and flexibility of the Simplex Coupling. This modern coupling allows deflections of as much as 5° at each joint . . . permits wide sweeps to be laid with straight lengths of Transite.

For details on Transite Pipe for water lines, write for brochure TR-11A. And for information on Transite Sewer Pipe for lower cost sewage-disposal systems, write for brochure TR-21A. Johns-Manville, 22 East 40th Street, New York, N. Y.



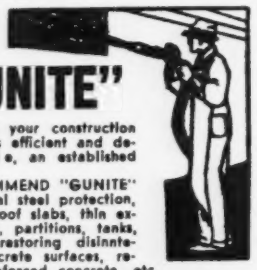




Johns-Manville

TRANSITE PIPE

An Asbestos Product for More Efficient, Economical Water & Sewer Lines



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can reduce your construction costs. It is efficient and dependable, an established product.
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"GUNITE" CONTRACTORS
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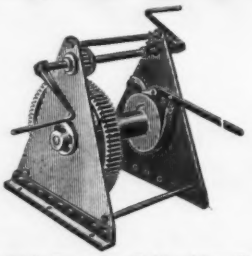

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Without obligating me in any way, mail a copy of your new descriptive bulletin "Your Dragline CAN Move Dirt Faster."

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sion of Sanitary Engineering. He succeeds Harry G. Hanson, who resigned recently to accept a position with the United States Public Health Service.

W. R. Holway and **Victor Cochrane**, engineers who designed an Oklahoma army cantonment, now under construction, have been retained under contract as consultants on construction, according to **Lieut. Col. H. A. Montgomery**, chief of the Corps of Engineers district office at Tulsa.

David H. Harker of Lafayette, Ind., has been appointed by the Ohio Water Supply Board to map the state's underground water reservoirs.

Harold E. Hedger, chief engineer of the Los Angeles County Flood Control District and president of the Los Angeles Section of the American Society of Civil Engineers, reported for active duty as a captain in the Corps of Engineers at Washington on March 17. **M. E. Salsbury,** senior assistant chief engineer, has been appointed acting chief engineer for the District.

Creed Caldwell has been appointed city engineer for Pine Bluff, Ark., succeeding H. T. Rudder, who recently was called into military service.

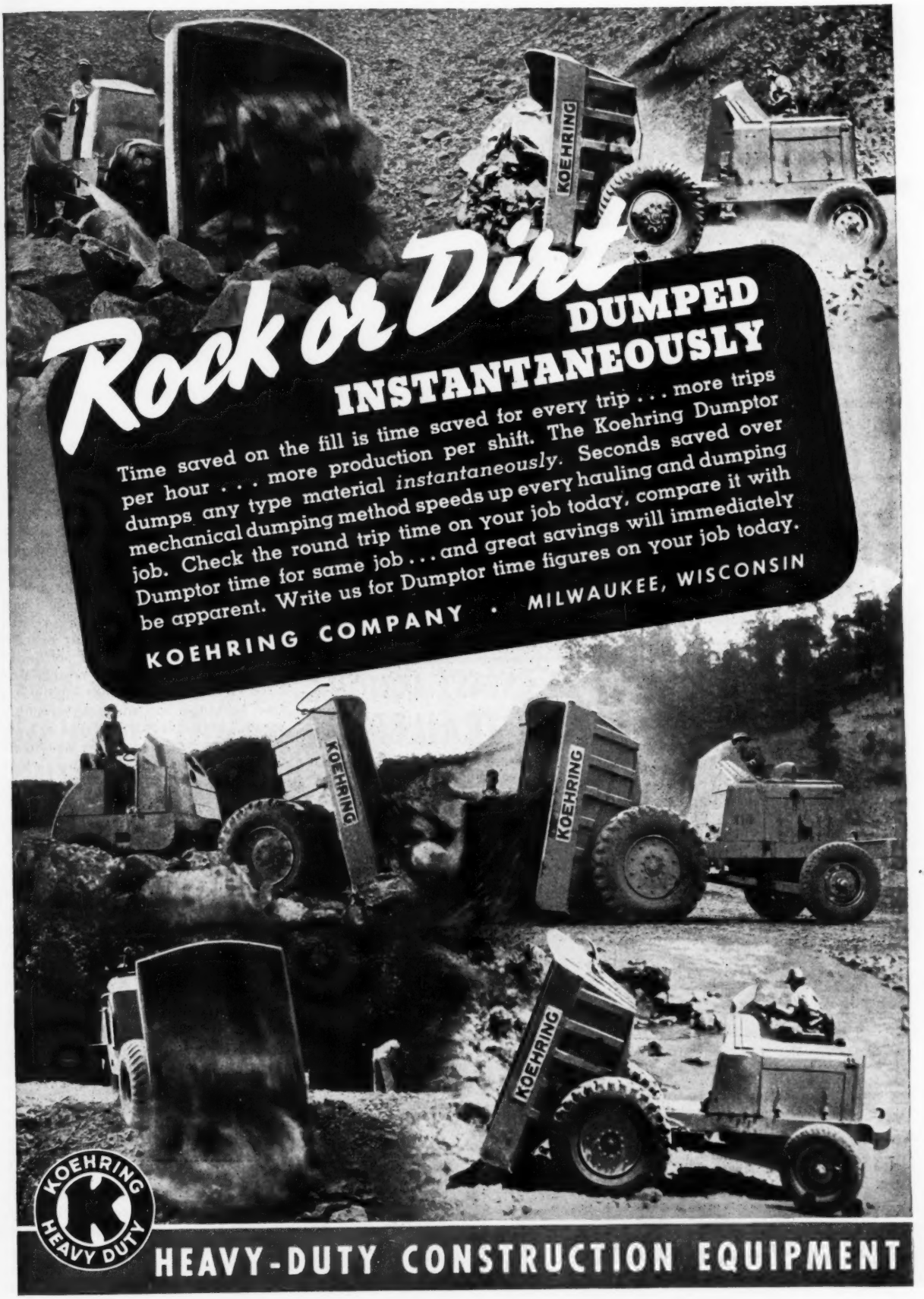
Recent changes in the staff of the Central of Georgia Railway include the promotion of **H. G. Carter,** division engineer of the Columbus Division to engineer of maintenance of way; **W. E. Chapman** from supervisor of Americus and Greenville Districts at Columbus, Ga. to division engineer at Columbus; **R. E. Sease** from supervisor at Albany, Ga. to supervisor at Columbus in charge of Americus and Greenville districts.

Charles H. Mottier, former chief engineer of the Illinois Central Railroad has become vice president in charge of the engineering department of the railroad succeeding **Fred L. Thompson,** who retired recently.

Roland A. Lemieux has been appointed engineer and secretary-treasurer for the municipality of Sillery, Province of Quebec, Canada.

Gerard Auger is now in charge of construction of the new rectifier station that is being built at Shawinigan Falls, Quebec, for the Aluminum Company of Canada.

A. S. Lyon, Rocky Mount, N. C., city purchasing agent and formerly superintendent of the water and light plant, has resigned after 38 years of service with the city.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INSTANTANEOUSLY
Time saved on the fill is time saved for every trip . . . more trips per hour . . . more production per shift. The Koehring Dumptor dumps any type material *instantaneously*. Seconds saved over mechanical dumping method speeds up every hauling and dumping job. Check the round trip time on your job today, compare it with Dumptor time for same job . . . and great savings will immediately be apparent. Write us for Dumptor time figures on your job today.
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Dig, Haul, Dump *in one operation!*

On jobs where materials are to be moved distances of several hundred feet or more, a SAUERMAN Drag Scraper or Cableway is a great money-saver because it will dig, haul and place the materials without the help of other equipment.

First cost of a SAUERMAN machine is reasonable, maintenance expense is small, and the simplicity of operation permits easy one-man control of even the largest installation.

This equipment is very flexible and is readily adapted to meet new and difficult working conditions. Sizes range from small portable units designed for cheap handling of a small hourly tonnage of loose materials up to powerful machines that will move as much as 1,000 tons per hour of the toughest materials.

Write for our catalog and see for yourself how others have cut costs on hundreds of dig-and-haul jobs with SAUERMAN Machines.

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SAUERMAN Scraper-Loader is a self-propelled unit of large capacity for loading material from pits or stockpiles.

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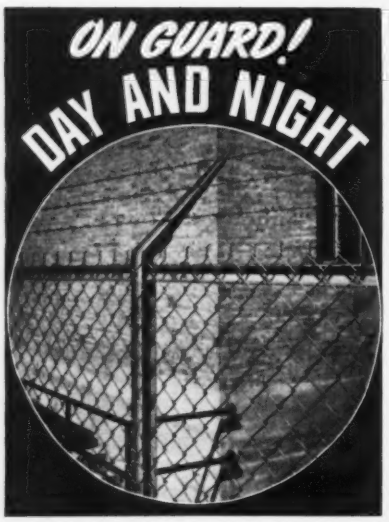

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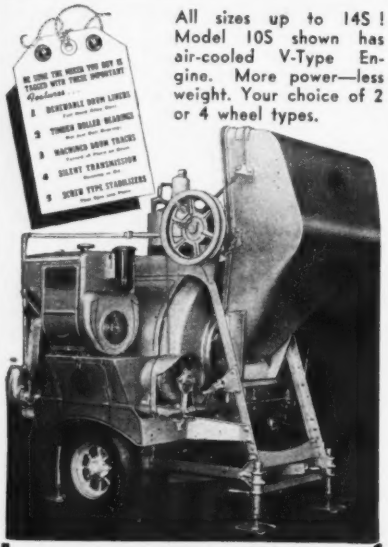

All sizes up to 14S! Model 10S shown has air-cooled V-Type Engine. More power—less weight. Your choice of 2 or 4 wheel types.

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New Aids to the Constructor

Glass fiber insulation

Insulating boards made of specially treated fiber glass are now being put on the market by the Owens-Corning Fiberglas Corp. to meet the shortage of cork insulating board created by the war. Fiber glass treated with a resin binder is compressed into standard 12 x 36-in. boards, 1, 1½ and 2 in. thick, and after the board has been formed the surfaces and edges are impregnated with asphalt of high melting point to exclude moisture.

The "Fiberglas AE (asphalt enclosed) Board" has a heat conductivity of 0.265 Btu. per square foot per hour per degree F. per inch of thickness, as compared to 0.277 for cork board; weighs slightly less than cork and has adequate structural strength for use in the insulation of roofs and cold storage rooms. The new material is believed to be superior to cork in the prevention of moisture penetration.

Dimensions and methods of application are identical with those heretofore used in insulating with cork board. Where more than one thickness is required, added layers are secured in place with wooden skewers, as shown in the accompanying photograph, the skewers being treated with a preservative. Costs are the same as for cork, and due to the curtailment of manufacture of refrigerators and gas stoves, which use large quantities of fiber glass for insulation, ample production capacity is available to meet the demand for insulating materials created by construction of new warehouses for military food supplies.

Synthetic Rubber Hose

A newer construction for its Type 400SS oil hose, with elimination of all natural rubber and substitution of its own synthetic rubber, Ameripol, is announced by the B. F. Goodrich Co. This type hose is also made with an Ameripol synthetic rubber tube, but with the cover and rubber used to impregnate the body piles of natural rubber. The new design

DUPONT CONSTRUCTION TOPICS DUPONT

FIRE AT AIRCRAFT PLANT
Retarded By "CZC" Treated Lumber

As construction progressed on one of the large new aircraft plants, a fire broke out in one of the buildings. The alarm was sounded. Firemen immediately rushed to the scene.

When they arrived, they noticed what was to them a peculiar thing. Parts of the wooden structure had been completely destroyed, while the frame and roof trusses were only charred on the surface—retarding the spread of fire to other sections.

Reason—the frame and roof trusses of this structure had been made of wood treated with Chromated Zinc Chloride for speedier construction and to prevent possible decay and termite damage. But another property of "CZC"-treated lumber—its fire resistance—had proved to be a major advantage in delaying the fire.

Thanks to "CZC," this fire never became a headline story. But it *is* a headline story for construction engineers. Think how important this quality of "CZC" treated lumber is today in the construction of armories, plane hangars, defense housing projects! Besides assuring safety and strength, lumber treated with "CZC" also permits great speed of construction because it is readily available—an important point to remember these days.

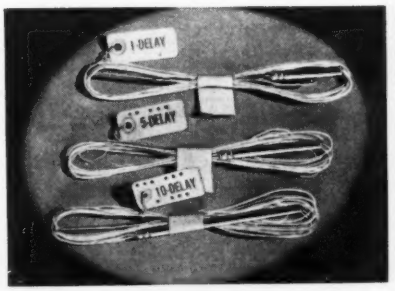
Write today for your copy of the booklet, "Facts about 'CZC'."

Du Pont Delay Electric Caps
Equipped with New Plastic Insulation

Du Pont Delay Electric Blasting Caps—long noted for their high degree of dependability in tunneling and other contracting work—are now equipped with an additional feature for increased reliability.

A new plastic insulation, developed in the du Pont research laboratories and tested under the most severe field conditions, is now standard for leg wires on these Delays. Abrasion resistance of the new insulation is superior to the best impregnated cotton coverings formerly used and electrical properties are equal to those of enameled wire. Furthermore, this new, bright-colored insulation stays clean so that wires are easy to identify under field conditions.

This announcement is made following the dependable performance in the field of several million Du Pont Electric Blasting Caps equipped with the new plastic insulation. This insulation is exclusive with du Pont and is available on all Du Pont Delay Electric Blasting Caps at no premium in price, to you.



Du Pont Delay Electric Caps with new plastic insulation. Note perforated tags (of contrasting colors) for accurate identification of delay periods.

NEW BOOK ON VENTILATION FOR TUNNELS

Safety and construction engineers will find a wealth of useful information in the new "Ventube"* handbook for 1942. This booklet is profusely illustrated with actual photographs of "Ventube" in use, and also with diagrams indicating recommended use of "Ventube" for best results.

The "Ventube" system of auxiliary ventilation has been widely used in practically every major tunneling job in the last decade, and du Pont research has never ceased in the search for ways of making it more efficient than ever. All of the recent improvements of "Ventube" are covered in this booklet.

Be sure to send for your copy. Write E. I. du Pont de Nemours & Co. (Inc.), "Fabrikoid" Division, Empire State Building, New York City

*"Ventube" is Du Pont's registered trademark for its rubber impregnated flexible ventilating duct.

DID YOU KNOW?

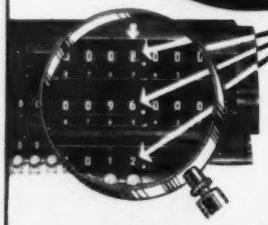
. . . **THAT OVER 4-½ BILLION** du Pont regular and electric blasting caps have been sold and used to date.

. . . **THAT ONE MAN** in a timbered entry or tunnel can put up over 400 feet of "Ventube" in two hours or less.

. . . **THAT SECOND-GROWTH LUMBER** treated with "CZC" has just as high mechanical strength as untreated virgin growth lumber.

★ ★ **E. I. DU PONT DE NEMOURS & CO. (INC.) WILMINGTON, DELAWARE** ★ ★

for the Field Office
and other uses!



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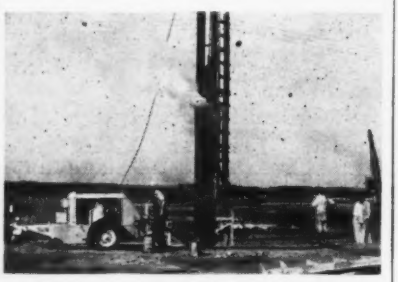
incorporates Ameripol in every part of the hose. All the hose is thus made resistant to the action of oils, gasolines or other solvents of natural rubber.—*The B. F. Goodrich Co., Akron, Ohio.*

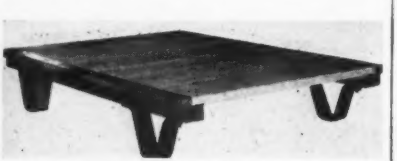
Brackets

Brackets ideally suited for scaffold horses, barricades for streets and highways, tables which can be knocked down, stored and moved from place to place, and many other purposes, are manufactured by Edward B. Brittin. The bracket is carefully designed and can be used on many construction jobs.—*Edward B. Brittin, 412 So. 7th St., Springfield, Ill.*



Heater Drives Piles

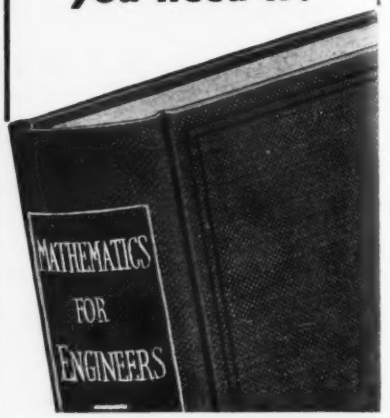
Designed originally to heat tank cars, the Littleford "Tankar" heater has been used for many other purposes. As shown in the above picture, the heater has been used as portable motive power for pile driving rigs.—*Littleford Bros., Inc., Cincinnati, Ohio.*



Skid Platform

A "Timber-Lock" skid platform, using no steel in the frame but giving all the strength inherent in steel welding, has been developed by Yale & Towne. Made of specially selected tough oak, a good part of the strength of the platform is traceable to a new interlocking "woodweld" process developed by Yale engineers to tie supporting leg runners and

MATHEMATICS YOU NEED
in the form you need it!



Experience showed Raymond W. Dull that for the practicing engineer a special kind of mathematics book was necessary. Convenience required that he have certain mathematical information available for quick reference. For this reason he prepared his own notes on mathematics in the course of his long engineering practice. At the suggestion of other engineers, Mr. Dull revised and extended his notes and the result of this was

MATHEMATICS for ENGINEERS

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This book gives you the mathematics you need in the form you need it. It is concise yet complete, a book for reference or study, as you wish, covering every phase of mathematics you are likely to meet, from simple numeric computations, through integration and summation. It is the kind of book that you will use again and again for a long period of years; and each time you use it, you will congratulate yourself on having it at hand.

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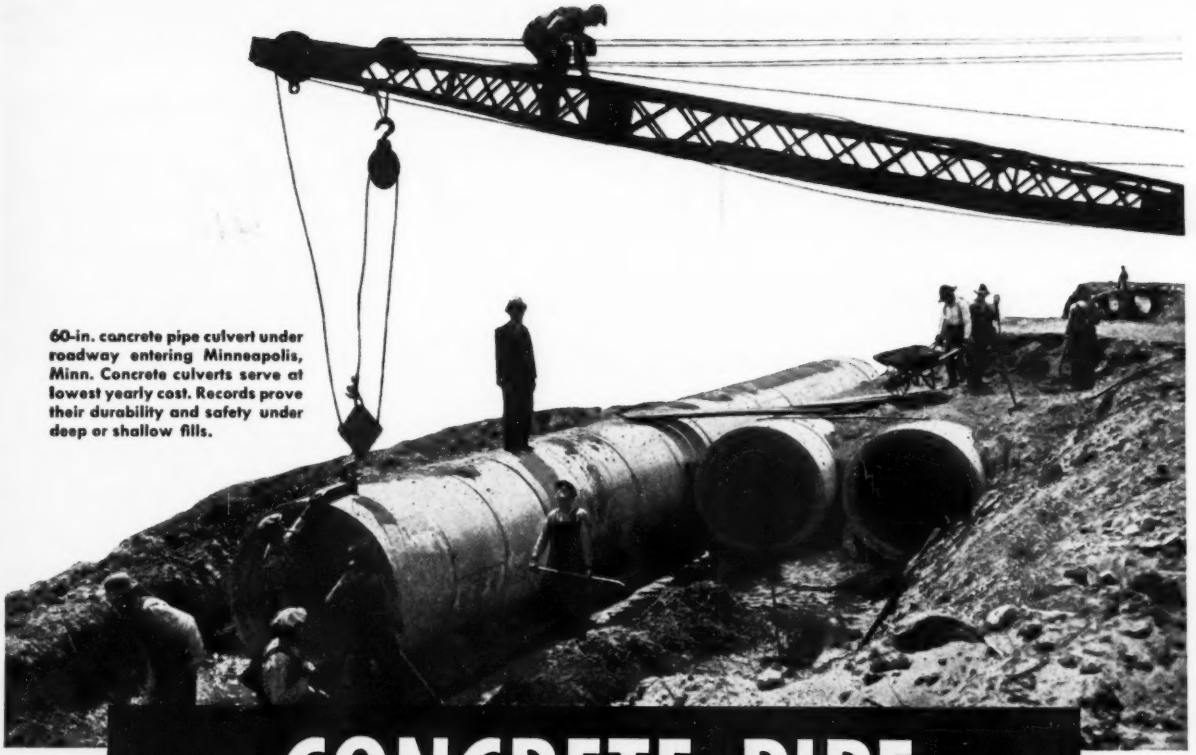

60-in. concrete pipe culvert under roadway entering Minneapolis, Minn. Concrete culverts serve at lowest yearly cost. Records prove their durability and safety under deep or shallow fills.

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is widely available for wartime culvert and drainage needs

Concrete pipe combines long life, maximum hydraulic capacity, great strength and low annual cost—as shown by thousands of installations under the nation's highways, railways and airports, and in municipal service. The rigid design and test requirements of A.S.T.M. specifications provide for concrete pipe of high quality.

And concrete pipe conserves critical materials. Established concrete pipe manufacturers are ready to serve you in nearly every community. Consult them about your needs.

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The assistance of our technical staff is available on your problems involving concrete pipe or other concrete construction.

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A national organization to improve and extend the uses of concrete . . . through scientific research and engineering field work

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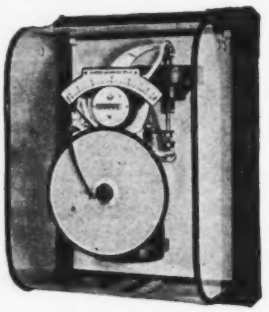
WATER MAIN LINE METERS

Your MASTER Records

Every man responsible for water service knows the danger of guessing. It is not enough to know the *rated* capacity of a pump. What is it doing right now?

THE instrument at the right tells all—direct totalization — present rate of flow—a complete picture of each 24 hours' or 7 days' deliveries. It can be installed close to, or miles away from, the Sparling Direct Action Meter that controls it.



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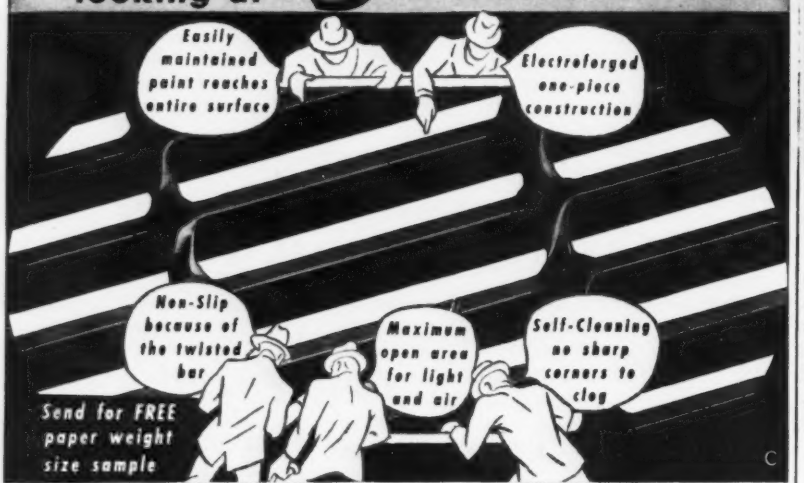
BLAW-KNOX GRATING

They are looking at 5 OUTSTANDING FEATURES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2001 FARMERS BANK BUILDING · PITTSBURGH, PA.

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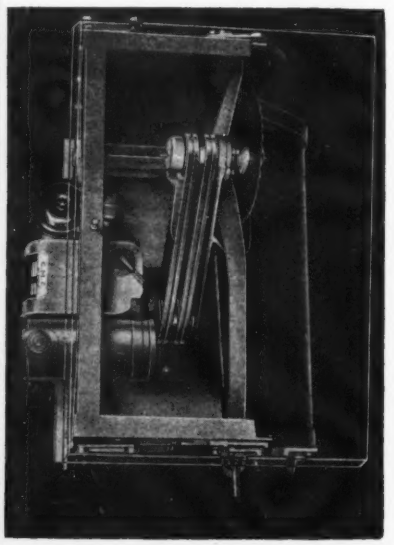
deck boards into one virtually inseparable unit.—*The Yale & Towne Mfg. Co., Philadelphia, Pa.*

Centrifugal Water Pump

A new model Rex centrifugal water pump, capable of moving 40,000 gal. of water per hour, is shown above. Located in a river bed, this pump is used after heavy rain storms as water supply for sprinkling trucks used in connection with the building of roads.—*Chain Belt Co., Milwaukee, Wis.*



Power Saw Meets Wide Demand

The new Kost Kutter streamlined 14 in. power saw shown above is particularly valuable in cutting, framing and other work, particularly on cantonments and other defense projects. Sturdily built, the unit will stand continuous use and handle a wide range of work.—*Construction Machinery Co., Waterloo, Iowa.*

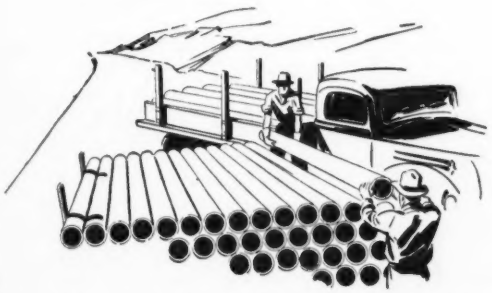
Sulphurized Cutting Oil

A new sulphurized cutting oil has been produced by Pawling Refining Corp., for high carbon steels, with special properties which speed up war production of machine tools, and all machining of steels high in carbon content.—*Pawling Refining Corp., Port Chester, N. Y.*

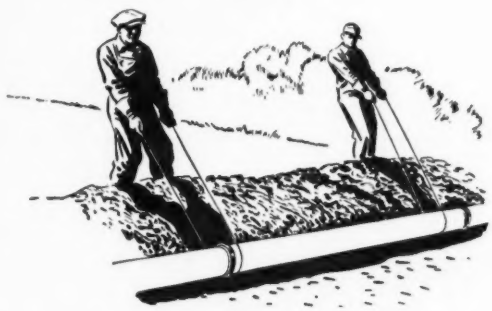
FROM TRAIN INTO TRENCH

K&M "Century" Pipe holds down costs

Hauling... "Century" Pipe's light weight permits bigger loads...the shipment arrives more quickly at the site, and the trucks are more readily available for other work.



Handling... "Century" Pipe's light weight minimizes the problem of unloading and handling.



Installing... Here again, "Century" Pipe's light weight will reduce expenses, for two men can easily lower it into the trench without the need of bulky, mechanical equipment.

THE moment you purchase K&M "Century" Pipe you'll start economizing. For "Century" Pipe is so light in weight that, from train to trench, it keeps costs down to a minimum.

"Century" Pipe will lower your labor costs, too . . . for workmen can quickly make tight, flexible joints. With the new "Century" 18 foot lengths, further economies are made possible because of a 28% reduction in the number of joints per mile. The 18 foot lengths are available in 6" and 8" sizes, class 150.

Installed in the trench, "Century" Pipe is practically maintenance-free. It never tuberculates, corrodes, nor is it subject to electrolysis . . . hence no protective coatings or linings are necessary.

Get full information on this leader in low-cost-per-mile by writing for our free booklet, "Mains without Maintenance." Address Dept. 1017.

Nature made asbestos; Keasbey & Mattison has made it serve mankind . . . since 1873

● "Century" Pipe is still available. Since we are cooperating fully with the war program, we cannot tell how long this favorable situation will continue.

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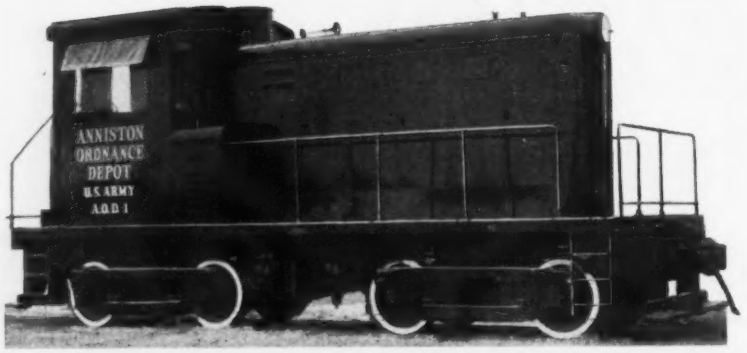
COMPANY, AMBLER, PENNSYLVANIA

DEPENDABILITY—*Vital to Victory*



Davenport Locomotives are assuming heavy responsibilities at many key centers of war activity. They will perform efficiently and dependably—moving VITAL WAR MATERIAL and conserving VITAL WAR TIME. The 45 ton Diesel-Electric, single engine unit, for the Anniston Ordnance Depot, typifies the many locomotives we are supplying to the Army, the Navy, our Allies, American war industries, and American war contractors. This keeps us busy but not too busy to meet the requirements of Davenport users who recognize their wartime responsibility for keeping their equipment in GOOD CONDITION.

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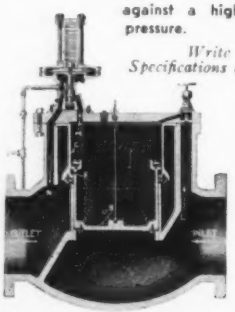
Single-Acting Semi-Throttling Altitude Valve

Installed in upstream line to tanks, standpipes or reservoirs, this valve sensitively maintains any desired water level to prevent overflow.

The valve is semi-throttling by gradually closing as water approaches the maximum water level to be controlled. The valve is self-contained without any waste of water from above the valve piston, and is especially desirable for service where a low head is to be maintained against a higher influent pressure.

Write for Specifications and Prices.



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NEW PUBLICATIONS

Fluorescent Lighting—A 35 page booklet "Facts, Questions, Answers on Fluorescent Lighting in Industry" has been prepared for non-technical readers to answer the popular questions in regard to cost, efficiency, advantages and maintenance of fluorescent lighting in industrial plants. Copies of this 5½x8½ in. booklet, A-4024, may be obtained by sending seven cents to cover mailing and production costs.—*Westinghouse Lamp Division, Bloomfield, N. J.*

Defense and Chlorination—A series of papers is available on emergency equipment for sanitary sterilization and quick chlorination.—*Proportioneers, Inc., 9 Codding St., Providence, R. I.*

Tournacrane—A 4-page bulletin describes the Tournacrane, a high-speed lifting tool for construction and industrial use, and shows job applications as well as giving complete information on lifting capacity and speed.—*R. G. LeTourneau, Inc., Peoria, Ill.*

Zinc—"Zinc in War" is the title of a pamphlet prepared to show some of the many reasons that zinc is a vital material at this time.—*The New Jersey Zinc Co., 160 Front St., New York.*

Block Rubber Tracks—Plentifully illustrated and with a large amount of data on a subject which is becoming increasingly important, an 8-page booklet on band and block rubber tracks for vehicles has just been published. The booklet discusses the principles of both types of tracks, illustrates their differences and tells their advantages over the steel crawler type of vehicle.—*B. F. Goodrich Co., Akron, Ohio.*

Wrought Iron—The A. M. Byers Co. has issued a new catalog to list for customers exactly which items are in stock or can be supplied immediately on order.—*A. M. Byers Co., Pittsburgh, Pa.*

Tramrail Engineering—A booklet covering much of the large subject of overhead materials handling giving details of the possibility of increasing warehouse and storage capacities, reducing floor congestion, promoting safety, and other factors.—*The Cleveland Crane & Engineering Co., Wickliffe, Ohio.*

Weights and Data—The fourth edition of the "Revere Weights and Data Handbook" has just come off the press. This new edition is particularly useful to many technical men in defense work and using copper or copper alloys in their works.—*Revere Coppper and Brass Incorporated, New York, N. Y.*

Manufacturers' Activities

GORDON L. CRAWFORD, previously sales manager of the Buffalo district, has been appointed assistant general sales manager with headquarters in New York for the WICKWIRE SPENCER STEEL CO.

EDWIN L. DENNIS, chief combustion engineer of the COPPUS ENGINEERING CORP., Worcester, Mass. has been relieved, at his own request, of his duties as an instructor at Louisiana State University at Baton Rouge, La.

CARNEGIE-ILLINOIS STEEL CORP.'s No. 3 Carrie furnace at the Rankin, Pa., plant set what is reported to be a new world's record for blast-furnace production during January when it produced 41,782 tons of pig iron during the month. The company also announced that it set two new steel rolling records in January. The 100-in. reversing plate mill at the Homestead Works produced 59,690 tons; the 140-in. plate mill of the Homestead Works had a record of 32,867 tons.

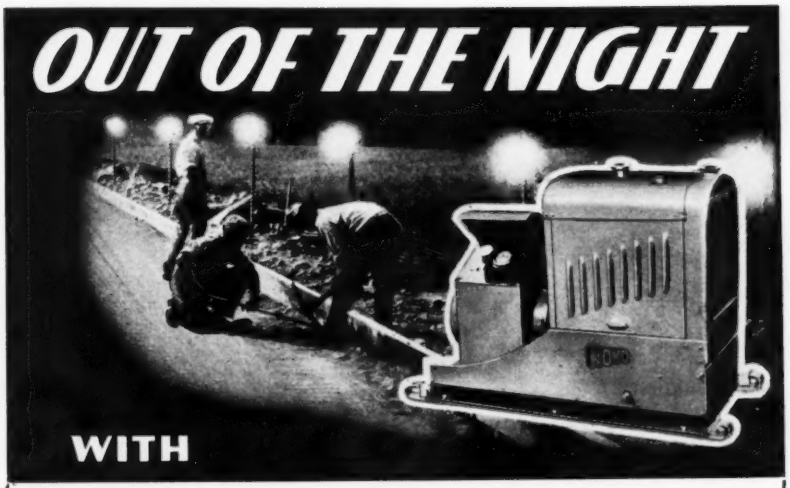
J. D. WOOD has resigned as president of the ROLLER-SMITH CO., in order to devote his entire time to his duties as chief engineer. REG HALLADAY, a director of the company since 1939, has been elected to the presidency.

C. M. MASON has been appointed district sales manager at Cleveland for the JONES & LAUGHLIN STEEL CORP., of Pittsburgh. Other changes in the organization include the appointment of E. H. HUGHES, formerly district sales manager at St. Louis, as district sales manager in Buffalo; L. S. BERKEY, formerly resident manager of sales at Toledo, has been appointed district sales manager at St. Louis; E. S. LEWIS, formerly of the Pittsburgh district sales office, has been appointed resident manager of sales in Toledo, and P. B. TURNER, formerly special representative in New York, has been appointed manager of export sales.

D. EDWIN GAMBLE, of Chicago, vice-president and general manager of the BORG and BECK DIVISION of the BORG-WARNER CORP., is now a member of the staff of the ordnance branch, production division of the War Production Board.

T. A. LYNCH, sales manager for the aeronautical industry for REYNOLDS METALS CO., INC., fabricators of aluminum parts, has been elected a vice president of the corporation.

Appointment of six men from the steel industry to key positions in the iron and steel branch, War Production Board, has



NOVO LIGHT PLANTS

NOVO LIGHT PLANTS will stretch your day to 24 hours. Unfailing, Unflickering light for the night shifts and a dependable source of power for small electric tools.

They have heavy duty, long life gasoline, gas or diesel power units—modern design, generator and engine are close coupled, switch board has weather proof cover, circuit breaker is used instead of fuses and open switch.

They are built in D C and A C models from 1 to 10 K W. Self starting and remote control available. Send the coupon.

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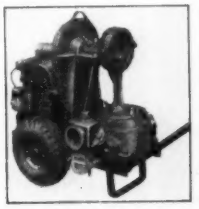
From 1½ to 8" sizes with big capacities, self-sealed design and 2 wear plates for easy adjustment.



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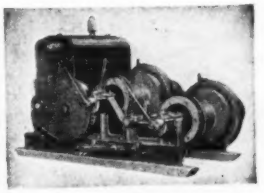

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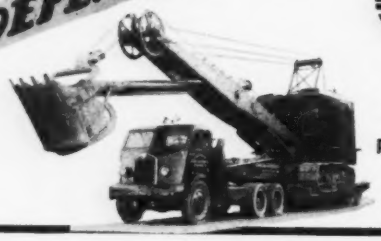

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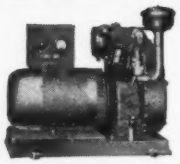

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operates at peak efficiency underwater regardless of materials being dredged.

OWEN special design minimizes wear in places subjected to the severest abrasive action.

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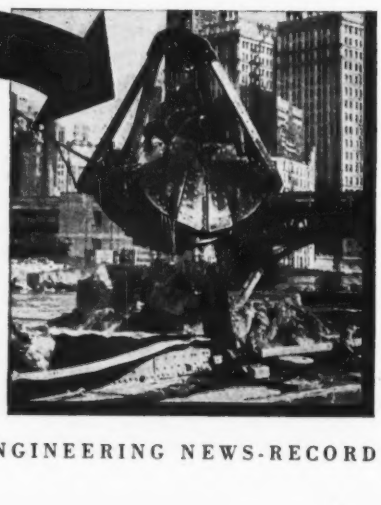

THE OWEN BUCKET COMPANY
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been announced. W. F. VOSMER, formerly sales manager of the carbon bar division of the REPUBLIC STEEL CORP., has been appointed head of the hot rolled carbon bar and semi-finished unit of the iron and steel branch; RALPH J. STAYMAN, Pittsburgh, formerly a special representative of the bar and semi-finished materials division of the CARNEGIE-ILLINOIS STEEL CORP., has been appointed head of the distressed stock unit; ORRIN H. BAKER, Chicago, formerly assistant manager of sales of the railroad materials division of the CARNEGIE-ILLINOIS STEEL CORP. has been appointed head of the rail unit. Three men have been appointed assistants to the head of the plate and shape unit. They are: A. L. MEYER, Wynnewood, Pa., who has been with the GREAT LAKES STEEL CORP.; A. S. HOFF, Chicago, who was with the INLAND STEEL CO., and R. A. MARBLE, Pittsburgh, of the Carnegie-Illinois Steel Corp.

POWER SPECIALTY CO., of Houston, Tex., has been appointed to represent the COCHRANE CORP. in southeastern Texas for the sale, installation, and service of Cochrane meters.

JACK YAUGER, district sales manager for the TRUSCON STEEL CO., has been called to active duty with the United States Army. He is succeeded in his post at Birmingham by ROBERT B. SMITH.

NOBLE B. PEAKE, JR., 41, sales engineer for the TENNESSEE COAL, IRON & RAILROAD CO., died March 7 at Birmingham.

ROBERT F. MOORE, 56, sales manager for PETER & BURGHARD STONE CO., cut building stone, died of a heart attack recently at his home in Louisville.

The acoustic division of BURGESS BATTERY CO. has announced a change of address to 2815 West Roscoe St., Chicago, effective March 30.

The SHARPSBURG CONSTRUCTION CO., 1400 N. Canal St., Sharpsburg, Pa., has been issued a certificate of incorporation by the state of Pennsylvania.

JOHN A. VOLPE, for the past nine years treasurer of GRANDE & VOLPE, announces the founding of his own firm, VOLPE CONSTRUCTION CO., with offices at 54 Eastern Ave., Malden, Mass.

Sale of one of the country's oldest and best known diesel engine manufacturing companies has been disclosed with the announcement of the purchase of the HILL DIESEL ENGINE CO., Lansing, Mich., by the EDWARDS CO., Sanford, N. C. Both companies will maintain executive offices at 724 Garrison Ave., New York City.

The ideal machine for compression tests of cement and concrete

Accepted by all authoritative bodies in the field, Southwark-Emery hydraulic compression testing machines meet requirements of Federal specifications and A.S.T.M. Tentative Specification 109-37T. Standard equipment includes loading-rate pacing discs.

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